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SEDIMENT DATA
MILK RIVER BASIN

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ABSTRACT

Sediment data were collected in the mid-seventies and the early eighties at seven gauging stations situated along the reach of the Milk River from above the western crossing of the International Boundary to immediately below its re-entry into the U.S.A. at its eastern crossing of the International Boundary. This report documents the available sediment information, presenting the data in various tabular and graphical formats.

In particular, for each gauging station, varying amounts of the following data are documented and discussed:

- descriptions of the gauging station sites (including air and ground photos)
- hydrometric details at the gauging stations sites
- suspended sediment data (concentration, load and particle size)
- bed material data
- dissolved solids data
- bed load data (only at the eastern crossing site)

The data are contained in individual appendices for each gauging station, while comparisons among the sites are contained within the main body of the report.

For the most part, sufficient data are available to make reasonable estimates of sediment loadings at various points along the Milk River reach, but these estimates must be based on procedures other than single line regression sediment discharge ratings.

SOMMAIRE

Les données sur les sédiments ont été recueillies au milieu des années soixante-dix et au début des années quatre-vingt, dans sept stations de calibrage situées le long de la rive droite de Milk River, entre l'endroit où elle franchit la frontière internationale à l'ouest jusqu'immédiatement au dessous de l'endroit où elle rentre aux États-Unis en refranchissant la frontière à l'est. Le présent rapport fait état des renseignements disponibles sur les sédiments, en présentant les données dans différentes tables et graphiques.

En particulier, pour chaque station de calibrage, les données suivantes sont données et commentées en nombres variables:

- descriptions des emplacements des stations de calibrage (incluant des photos aériennes et terrestres);
- détails hydrométriques relevés aux emplacements des stations de calibrage;
- données sur les sédiments en suspension (concentration, densité et dimensions des particules);
- données sur les matériaux du lit;
- données sur les matériaux solides dissous;
- données sur la charge du lit (seulement à l'endroit où la rivière franchit la frontière à l'est).

Les données se trouvent dans des annexes propres à chaque station de calibrage, alors que les comparaisons entre les emplacements figurent dans le texte du rapport.

Dans l'ensemble, les données sont suffisantes pour faire des estimations raisonnables sur les charges de sédiments à différents points le long de la rive droite de Milk River, mais ces estimations doivent se fonder sur des procédés différents des estimations des décharges de sédiments de régression en une seule ligne.

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TABLE OF CONTENTS

Page

ABSTRACT i

ACKNOWLEDGEMENTS iii

TABLE OF CONTENTS iv

LIST OF FIGURES v

LIST OF TABLES vi

1.0 INTRODUCTION 1

1.1 Purpose 1
1.2 Scope 2

2.0 BASIN DECRIPTION AND HYDROLOGY 3

2.1 Physiography 3
2.2 Climate 6
2.3 Hydrology and Flow Regulation 6

3.0 AVAILABLE DATA AND COMPARISONS ALONG REACH 10

3.1 Streamflow Information 10
3.2 Suspended Sediment Data 11
3.3 Hydraulic Data 13
3.4 Suspended Sediment Particle Size Data 15
3.5 Bed Material Data 16
3.6 Dissolved Solids Data 18
3.7 Bed Load Data 18

4.0 SUSPENDED SEDIMENT LOAD 19

5.0 DIVERSION EFFECTS 25

6.0 SUMMARY AND RECOMMENDATIONS 27

REFERENCES 28

APPENDICES:

A. North Milk River above St. Mary Canal A-1
B. North Milk River near International Boundary B-1
C. Milk River at Western Crossing C-1
D. Milk River at Milk River D-1
E. Milk River near Writing-on-Stone Park E-1
F. Milk River near Pendant D'Oreille F-1
G. Milk River at Eastern Crossing G-1

LIST OF FIGURES

Page

FIGURE 1: Milk River Basin Including Gauging Stations 3

FIGURE 2: Milk River Hydrographs 7

FIGURE 3: Flood Frequencies of Streams in Milk River Basin 9

FIGURE 4: Bed Material Particle Size Variation Along the Milk River 16

FIGURE 5: Plot of Instantaneous Suspended Sediment Concentrations Versus Discharge (North Milk River near International Boundary, 1976) ... 23

FIGURE 6: Plot of Instantaneous Suspended Sediment Concentration Versus Discharge (Milk River at Eastern Crossing, 1974 to 1982) 24

LIST OF TABLES

Page

TABLE 1: Channel and Valley Features 5

TABLE 2: Mean Monthly Flows in the Milk River 8

TABLE 3: Milk River Gauging Stations 10

TABLE 4: Sediment Program in Milk River Basin 11

TABLE 5: Number of Suspended Sediment Samples 12

TABLE 6: Hydraulic Data at Various Flows for the Main Stem Gauging Stations Derived from High Water Streamflow Discharge Measurements. 14

TABLE 7: Suspended Sediment particle Size Information. 15

TABLE 8: Locations of Bed Material Samples Taken by Halferdahl. 17

TABLE 9: Comparison of Monthly Suspended Sediment Load and Mean Monthly Discharge. 19

TABLE 10: Loads and Concentrations Along the Reach of the Milk River. 20

1.0 INTRODUCTION

The Milk River Basin lies along the International Boundary, between the United States and Canada. The river arises in the United States, crosses into Canada, where it parallels the border before swinging south to re-enter the United States (Figure 1). The uniqueness of its location has provided the United States the opportunity to use the Milk River as a conveyance channel for irrigation waters; that is, the United States divert their share of the St. Mary River into the western end of the Milk River system, lead it through Canada, and back into the United States, eventually to be used for irrigation.

The diversion of St. Mary River waters into the Milk River began in 1917 and every year since then, during the irrigation season, the Milk River has been used as a conveyance channel. Naturally this diversion has altered the flow regime, which impacts on the sediment regime.

The Milk River and the allocation of its water is governed by the 1909 Boundary Waters Treaty between Canada and the United States. Article VI specifically deals with the apportionment of the waters of the St. Mary and Milk rivers and the use of the Milk River as a conveyance channel. During spring runoff and large rainstorm events, Canada has been unable to fully utilize its share of the natural flow of the Milk River. Conversely, during dry periods, insufficient flow is available to meet the demands of Canadian irrigators. Thus, in recent years the Alberta Government has investigated the potential for building a dam to capture Canada's share in times of excess flow, retaining this until required.

A number of gauging stations have been installed at strategic points along the reach of the Milk River to monitor the flow, to calculate the natural flow, and to ascertain the utilization of the waters by each country. The change in flow regime has caused concern as to what effects this might have on the river's bed and banks over an extended period of time. Thus, to provide data to assist in the analysis of the channel response to the altered flow regime and to provide information on sediments for engineering applications, sediment data collection programs were conducted at a number of sites during 1974 to 1976 and again in 1981 and 1982. After 1982, a miscellaneous suspended sediment program (the collection of a depth-integrated suspended sediment sample at a single vertical on each trip to the station by the field technician) has been carried out at only one site (Milk River at Milk River).

1.1 PURPOSE OF REPORT

This report presents a summary and analysis of all sediment data collected by Water Survey of Canada and by the United States

Geological Survey at various sites in the Milk River Basin. The main objective of this report is to present these data in concise and readily usable formats for engineering and other applications. Secondary objectives are to include information on basic channel characteristics at each gauging station and to present basic interpretations on the sediment regime at each site and to compare these sites. In addition, the presentation and analyses of these data will prove useful in the future planning and implementation of a sediment program in the Milk River Basin.

1.2 SCOPE OF REPORT

This report begins with a description of the Milk River Basin, including physical characteristics, climate, hydrology and flow regulation. This is followed by a summary detailing the available data, including streamflow, sediment and hydraulics. As only a limited amount of sediment data exists, it is only possible to make crude estimates of sediment discharge at various sites. These "estimates" are included, but must be used with extreme caution in that the simulated sediment discharge data may be grossly in error.

All available sediment data are contained in individual appendices for each gauging station. Each of these appendices contains various tabular and graphical presentations of the sediment data, including plots of concentration versus discharge, listings of instantaneous discharge and suspended sediment concentrations, particle size information plots and tables (for both suspended and bed materials). In addition, each appendix includes information (tabular and graphical) on hydraulic parameters at the gauging station. Each appendix also contains a description of the hydrometric station, a description of the sediment program and may contain some information on bed load discharge and dissolved solids.

2.0 BASIN DESCRIPTION AND HYDROLOGY

2.1 PHYSIOGRAPHY

The Milk River rises in Glacier National Park in northwestern Montana, in the foothills of the St. Mary Ridge. The river flows in a northeasterly direction into Canada along two tributaries, the Milk River and the North Milk River. The two branches join approximately 21 kilometres west of Milk River. This confluence lies directly south of the Milk River Ridge, a drainage divide between waters flowing to the Hudson Bay (Arctic Ocean) and to the Gulf of Mexico. After the confluence, the river generally meanders in an easterly direction and then eventually southeasterly before re-entering the United States some 113 km east-southeast of Milk River. In the United States the Milk River eventually flows into the Missouri River, hence the Mississippi and the Gulf of Mexico.

Several small tributaries join the Milk River in its course through Canada. Most of these arise from the flanks of the Sweetgrass Hills in Montana. Other tributaries join the river along the left (north) bank from southeasterly trending valleys.

The Milk River and specific points of reference in the Milk River Basin are depicted in Figure 1.

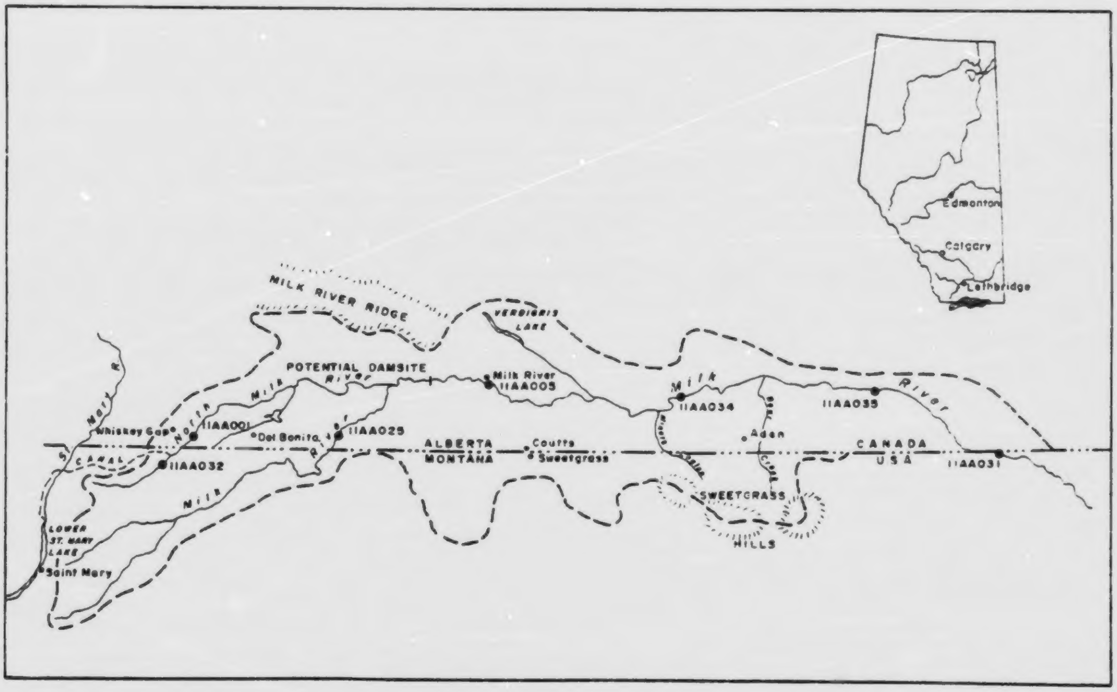
Edmonton
Calgary
Lethbridge
MILK RIVER RIDGE
VERDIGRIS LAKE
POTENTIAL DAMSITE
Milk River
11AA005
Mary R.
North Milk
River
Whiskey Gap
11AA001
Del Bonita
11AA025
ALBERTA
MONTANA
Coutts
Sweetgrass
CANAL
11AA032
Milk
LOWER ST. MARY LAKE
Saint Mary
Milk
11AA034
11AA035
River
Aden
CANADA
USA
11AA031
Creek
SWEETGRASS
HILLS

Figure 1.

Milk River Basin, Including Gauging Stations

The valley of the Milk River, broad in the western portion and canyon type in the east, was not cut by the stream, but rather is the result of the last ice age some 10,000 years ago, when water from the melting ice cut a series of wide channels. Because ice still blocked the natural runoff to the north, the Milk River received melt water from the Saskatchewan River drainage area and therefore became a wide torrent, carving a large valley. Ultimately, the present drainage system became established, leaving a much shrunken Milk River in an oversized valley.

Most of the physical landscape of the basin is a broad, gently rolling plain through which the Milk River valley is cut.

The North Milk River and much of the upper Milk River flow is in a stream cut valley along the course of a much older pre-glacial drainage channel. As a result, the valley is generally wide (up to about 2km) and has walls composed of glacial till or other valley fill sediments, underlain by sandstone. Occasionally, the river has been deflected outside the course of its pre-glacial channel and in these places the valley is steep-walled and narrow.

Downstream of Milk River townsite several wide coulees intersect the Milk River valley. These coulees represent former glacial meltwater channels which flowed at the end of the last continental glaciation. For most of its lower course the Milk River flows in one of these meltwater channels. Throughout part of this lower reach the combination of low rainfall, lack of vegetation and presence of erodable valley deposits has produced extensive areas of badlands which contribute large quantitites of silt and sand sized sediment to the Milk River.

Table 1 contains information on channel and valley features along the Milk River's reach. The data were extracted from aerial photographs and personal knowledge of the site. The classifications and interpretations are based on an abbreviated form of that developed by Kellerhals et al.(1976).

TABLE 1

CHANNEL AND VALLEY FEATURES

	NORTH MILK RIVER ABOVE CANAL (11AA032)	NORTH MILK RIVER NEAR INTERNATIONAL BOUNDARY (11AA001)	MILK RIVER AT WESTERN CROSSING (11AA025)	MILK RIVER @ MILK RIVER (11AA005)
GENERAL DESCRIPTION IN VICINITY OF HYDROMETRIC STATION (ABOVE VALLEY)				
Terrain	Plains	Plains	Plains	Plains
Vegetation	Grass	Grass	Grass	Grass
Land Use	Partially Cultivated	Partially Cultivated	Partially Cultivated Left Bank No Cultivation Right Bank	Mainly Cultivated, Partly Urbanized
VALLEY CHARACTERISTICS ABOVE VALLEY FLAT				
Slumping of Valley Walls	None	None	Occasional	None
Vegetation on Valley Walls	Grass	Grass	Grass	Grass
TERRACES				
Presence	None	Fragmentary	Fragmentary	Continuous
Number of Levels	Not Applicable	Several Levels	Several	Several
RELATION OF CHANNEL TO VALLEY				
Valley Type	Not Applicable	Stream Cut Valley	Stream Cut Valley	Not Applicable On Alluvial Plain
Relation of Channel to Valley Bottom	Not Obviously Aggrading or Degrading	Not Obviously Aggrading or Degrading	Partially Entrenched	Not Applicable
Relation of Channel to Valley Walls or Resistance Terraces	Not Applicable (no valley)	Frequently Cultivated	Frequently Confined	Frequently Confined
DESCRIPTION OF VALLEY FLAT				
Presence	Continuous	Fragmentary	Fragmentary	Continuous
Extent	Narrow (<one stream width)	Moderate (1 to 5 channel widths)	Moderate (1 to 5 channel widths)	Moderate (1 to 5 stream widths)
Vegetation	Grass and Shrubs	Grass and Shrubs	Grass	Grass and Shrubs
Land Use	Not Cultivated	Not Cultivated	Not Cultivated	Partly Cultivated
CHANNEL DESCRIPTION				
Pattern	Tortuous Meanders	Irregular	Irregular	Irregular
Islands	None	None	None	Very Infrequent
Bar Type	Side Bars, Mid-channel Bars	Point Bars	Point Bars	Point and Side Bars
Type of Flow	Uniform with Rapids in Reach	Uniform with Rapids in Reach	Uniform with Rapids in Reach	Uniform with Rapids in Reach
LATERAL CHANNEL ACTIVITY				
Lateral Activity	Not Detectable	Progression and Cut-offs	Not Detectable	Progression and Cut-offs
Lateral Stability	Stable	Moderately Unstable	Stable	Slightly Unstable
CHANNEL BANK AND BEDS				
Alluvial Bank Material	Clay and Silt	Gravel Overlain by Silt	Cobbles Overlain by Silt	Silt and Sand
Bank Vegetation	Grass and Shrubs	Grass	Grass, Small Shrubs	Grass and Shrubs
Predominant Bed Material	Sand with local gravel	Gravel	Sand and Gravel to Cobbles	Sand and Gravel

	MILK RIVER NEAR WRITING-ON-STONE PARK (22AA034)		MILK RIVER NEAR PENDANT D'OREILLE (11AA075)	MILK RIVER AT EASTERN CROSSING (11AA031)
GENERAL DESCRIPTION IN VICINITY OF HYDROMETRIC STATION (ABOVE VALLEY)	UPSTREAM OF GAUGE	DOWNSTREAM OF GAUGE		
Terrain	Plains	Plains	Plains with Localized Badlands	Plains with Localized Badlands
Vegetation	Grass	Grass	Grass	Prairie Grasses
Land Use	Partly Cultivated	Partly Cultivated	No Cultivation	North: - No Cultivation South: - Partly Cultivated
VALLEY CHARACTERISTICS ABOVE VALLEY FLAT				
Slumping of Valley Walls	None	None	Occasional	Occasional to Frequent
Vegetation on Valley Walls	Grass	Grass	Almost None	Almost None
TERRACES				
Presence	Fragmentary	Fragmentary	Fragmentary	Fragmentary
Number of Levels	Two	Two	Several	Several
RELATION OF CHANNEL TO VALLEY				
Valley Type	Stream Cut Valley	Stream Cut Valley	Stream Cut Valley	Stream Cut Valley
Relation of Channel to Valley Bottom	Entrenched	Not Obviously Aggrading or Degrading	Partly Entrenched	Not Obviously Degrading or Aggrading
Relation of Channel to Valley Walls or Resistance Terraces	Entrenched	Entrenched	Confined	Frequently Confined
DESCRIPTION OF VALLEY FLAT				
Presence	Fragmentary	Fragmentary	Fragmentary	Fragmentary
Extent	Narrow (less than one stream width)	Narrow (less than one stream width)	Moderate (1 to 5 water surface widths)	Wide (>5 water surface widths)
Vegetation	Grass	Grass and Shrubs	Grass and Shrubs	Grass and Shrubs
Land Use	Not Cultivated	Not Cultivated	Not Cultivated	Not Cultivated
CHANNEL DESCRIPTION				
Pattern	Irregular	Irregular	Irregular Meanders	Irregular Meanders
Islands	None	None	Occasional (sand bars)	Frequent (Sand Bars)
Bar Type	Side and Mid-Channel Bars	Point, Side and Mid-Channel Bars	Point, Side and Mid-Channel	Point, Side & Mid-Channel Bars
Type of Flow	Uniform with Rapids in Reach	Uniform with Rapids in Reach	Uniform Water Surface	Uniform Water Surface
LATERAL CHANNEL ACTIVITY				
Lateral Activity	Not Detectable	Not Detectable	Downstream Progression	Progression and Cut-offs
Lateral Stability	Stable	Stable	Moderately Unstable	Slightly Unstable
CHANNEL BANK AND BEDS				
Alluvial Bank Material	Sand and Silt	Sand and Silt	Silt and Sand	Clay and Silt (Cohesive)
Bank Vegetation	Moderately Erodable Rock	Moderately Erodable Rock	Grass and Shrubs	Grass and Shrubs
Predominant Bed Material	Sand	Sand	Sand	Sand

2.2 CLIMATE

Most of the drainage area, particularly the eastern two-thirds, lies within a semi-arid region and as such is one of the driest climatic regions in Canada. The mean annual precipitation is 340 mm and varies from 260 to 380 mm. Many of the summer days (45 to 55) experience temperatures above 26°C which, combined with frequent, strong Chinook winds, results in a substantial water deficit from May to October. This deficit becomes progressively more extreme eastwards across the basin with a decreasing annual precipitation. Naturally, with this net loss, water supplies for irrigation purposes becomes extremely important.

The eastern two-thirds of the Milk River Basin lies within the short grass ecoregion (brown chernozem soil zone). With the exception of the foothills area in the United States, which is covered with forest or shrubs, the remainder of the basin is in the mixed grass ecoregion (dark brown chernozem soils). This mixed grass ecoregion receives somewhat higher precipitation levels than the short grass ecoregion.

2.3 HYDROLOGY AND FLOW REGULATION

With the exception of the south fork of the Milk River and the north fork of the Milk River above the St. Mary Diversion Canal confluence the flow regime in the Milk River system has been altered since 1917. Under natural flow conditions the normal Milk River hydrograph would indicate high runoff in late March or early April due to snowmelt runoff and perhaps again in May, June or July due to intense localized rainstorms. Between peaks, the flows would quickly recede and in the absence of summer rainstorm events, natural flows would become exceedingly low and in drought years could drop to zero.

The main effect of the diversion of St. Mary River waters to the Milk River has been to maintain flows in the Milk River between 15 to 20 m^3/s from May to September. Thus, after the peak runoff in the spring, the hydrograph shape is that of a plateau through May to September with an abrupt dropoff when the diversion is stopped.

Figure 2 depicts the average streamflow hydrographs over the period of record for the North Milk River above the St. Mary Canal and near the International Boundary, and the Milk River at Milk River, and at Eastern Crossing.

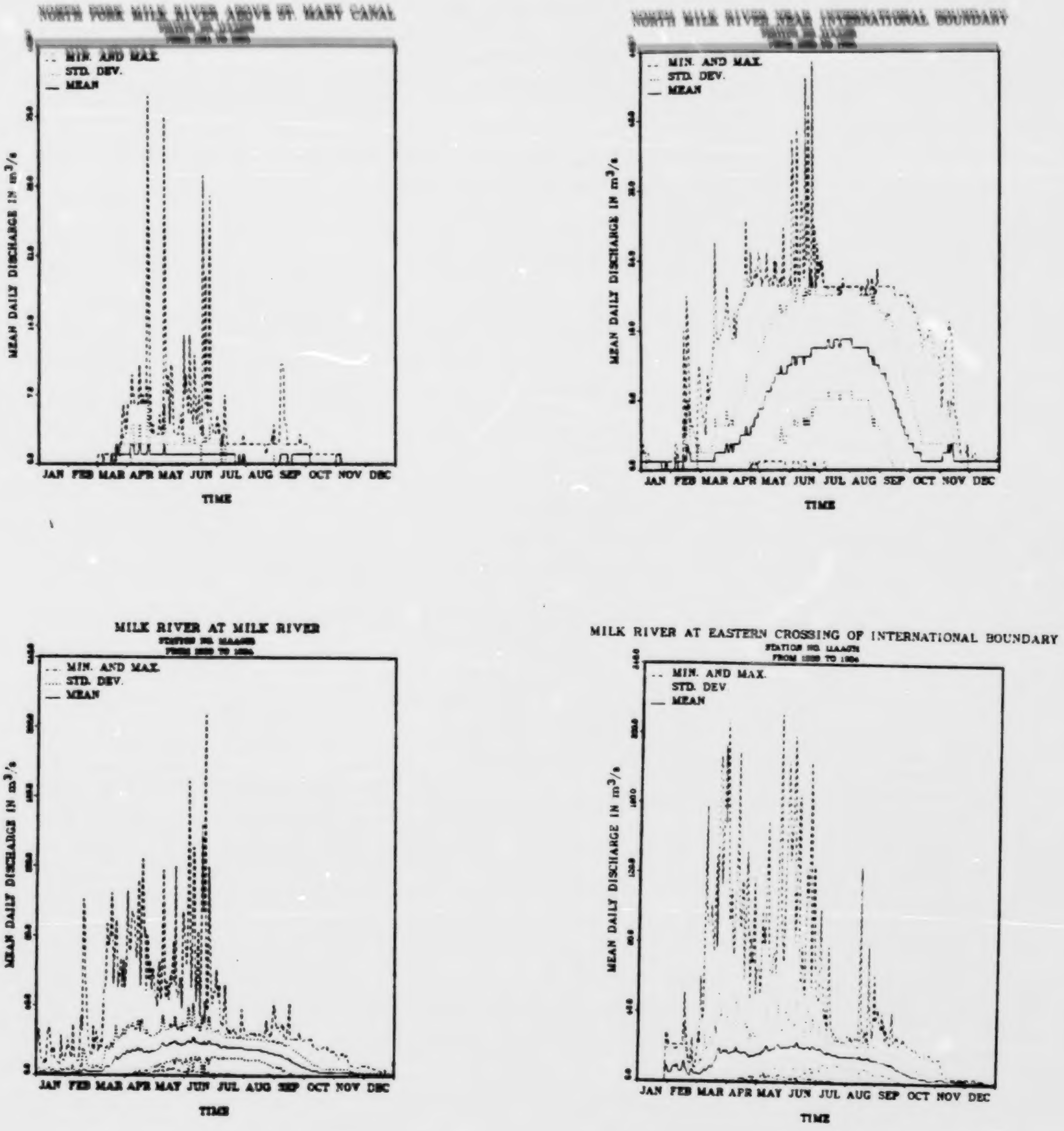

Figure 2

Milk River Hydrographs

Table 2 which follows, provides a comparison of flows among the various gauging stations located along the reach of the Milk River. In particular, the differences between the stations on the North Milk River should be noted. These stations are only separated by a few kilometres, but the North Milk River above St. Mary Canal (11AA032) is virtually natural flow, whereas the flows of the station North Milk River near the International Boundary (11AA001) have been swelled by the St. Mary River diversion. Similarly, the recorded flows in the Milk River at Western Crossing (11AA025) are for the most part natural flows and thus the combined flows of 11AA025 and 11AA032 would roughly be equivalent to the natural flow at Milk River @ Milk River (11AA005).

TABLE 2

MEAN MONTHLY FLOWS IN THE MILK RIVER
(m^3/s)

STATION	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Seasonal Means
North Milk River ab. Canal	0.47	1.22	1.04	0.87	0.55	0.46	0.53	0.49	0.65
N. Milk R. nr Intn'l B'dnry	1.56	4.22	9.93	13.0	14.5	13.6	7.68	1.58	8.62
Milk R. at Western Crossing	2.72	6.48	6.38	5.21	1.60	0.57	0.57	0.66	3.02
Milk River at Milk River	6.19	13.9	17.4	18.9	16.3	14.4	9.08	2.78	12.3
Milk R. at Eastern Crossing	10.5	16.5	19.0	20.3	16.6	14.4	9.88	3.34	14.7

The St. Mary River diversion has also substantially altered the frequency of floods, particularly on the North Milk River. This effect can be illustrated by comparing the flood frequency curves for the gauge site above the canal (11AA032) and below the canal (11AA001) (Figure 3). It is apparent that in many dry years when rainstorm and snowmelt floods have been absent, the diversion releases govern the annual flood on the river. The mean annual flood on the North Milk River has been increased eight fold. In addition to increasing the flood flows, the diversion has greatly increased the duration of high water each year. For example, the discharge of 13 m^3/s which has been maintained on average for three months (June, July and August) would have corresponded to a one-in-thirteen year flood under natural conditions.

On the other hand, the effect of the diversions on floods along the mainstem of the Milk River has been minor due to the much greater drainage area along the reach. The maximum recorded canal flow of 22 m^3/s corresponds to only about 33% of the mean annual flood recorded at Milk River at Eastern Crossing (11AA031). The maximum recorded flow (300 m^3/s) is more than thirteen times greater than the maximum canal flow.

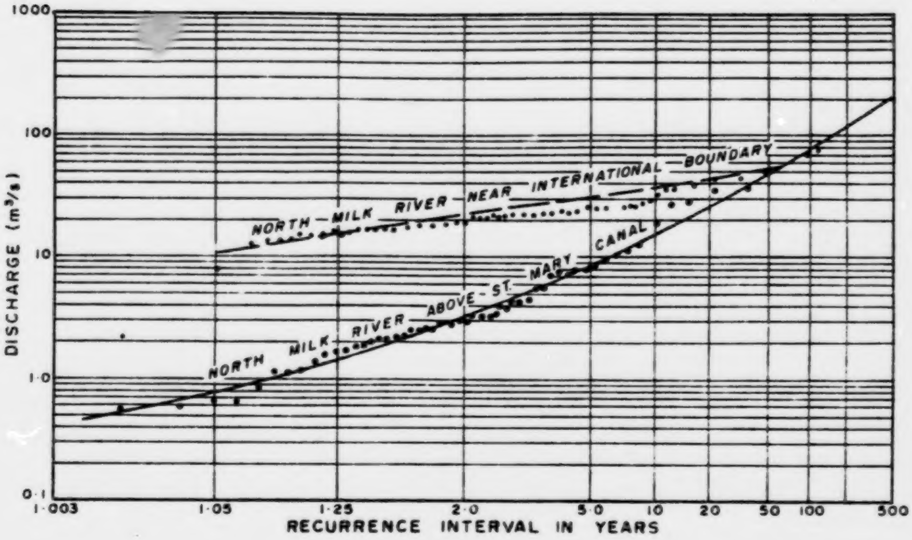

Figure 3

Flood Frequencies of Streams in Milk River Basin

Therefore, although the canal has substantially increased the monthly flows along the entire river, significant increases in peak flows have only occurred on the North Milk River below the canal.

The previous three paragraphs are a nearly word-for-word extraction from McLean and Beckstead (1981), with updated information.

3.0 AVAILABLE DATA AND COMPARISONS ALONG REACH

3.1 STREAMFLOW INFORMATION

At present, six gauging stations are being operated on either the mainstem or on the north or south forks of the Milk River. Many of these stations have been operated since the early nineteen hundreds. As well, four gauging stations in Canada are being operated on tributaries to the Milk River above Eastern Crossing. Numerous stations have been established and discontinued along the Milk River and within the basin, details for which can be found in the Surface Water Data Reference Index, Canada, 1986.

Pertinent gauging stations along with the station number, drainage area and period of record are detailed in Table 3.

TABLE 3

MILK RIVER GAUGING STATIONS

STATION	Number	Drainage Area (km^2)	Period of Record
South Fork Milk River near Babb	11AA033	181	1911/12; 1919 to present
Milk River at Western Crossing	11AA025	1050	1932 to present
North Milk River above St. Mary Canal	11AA032	156	1909 to present
North Milk River near International Boundary	11AA001	252	1909 to present
Milk River at Milk River	11AA005	2720	1909 to present
Milk River near Writing-on-Stone	11AA034	4390	1978 to 1982
Milk River near Pendant D'Oreille	11AA035	6040	1978 to 1982
Milk River at Eastern Crossing	11AA031	6490	1909 to present

For the most part the gauging stations included in Table 3 are (or were) operated on a March to October basis; the exception being the Milk River at Milk River (11AA005), which has been operated on a continuous basis since 1911.

Milk River streamflow information can be found in the annual Surface Water Data publications or in the Historical Streamflow Summary, Alberta, 1984, or upon request to the Regional Engineer, Water Resources Branch, Calgary.

3.2 SUSPENDED SEDIMENT DATA

Table 4 indicates the type and lengths of sediment program which were conducted at the various gauging stations along the Milk River. Table 5 contains details on the number of samples taken at each site. The actual data are contained in the respective appendix for each gauging station, while Section 4 of this report provides a brief comparison of loads at various points along the river.

TABLE 4

SEDIMENT PROGRAM IN MILK RIVER BASIN

STATION	Number	YEAR							
		1974	1975	1976	1981	1982	1983	1984	1985
North Milk R. ab Canal	11AA032	M	M	M	-	-	-	-	-
North Milk R. nr Int'l B'ndry	11AA001	M	S	S	S	M	-	-	-
Milk R. at Western Crossing	11AA025	M	M	M	M	M	-	-	-
Milk R. at Milk River	11AA005	M	M	M	S	S	M	M	M
Milk R. nr Writing-on-Stone	11AA034	-	-	-	M	M	-	-	-
Milk R. nr Pendant D'Oreille	11AA035	-	-	-	M	M	-	-	-
Milk R. at Eastern Crossing	11AA031	M	S	M	S	S	-	-	-

M - Miscellaneous Program
S - Seasonal Suspended Sediment Program

TABLE 5

NUMBER OF SUSPENDED SEDIMENT SAMPLES

SITE	MONTH								TOTAL
	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	
1974									
N. Milk R. ab Canal	-	-	2	1	1	1	1	1	7
N. Milk R. nr Int'l B'ndry	-	-	2	2	1	1	2	1	9
Milk R. at Western X'ing	-	-	2	1	1	1	1	1	7
Milk R. at Milk River	-	-	2	1	1	1	2	1	8
Milk R. at Eastern X'ing	-	1	3	2	2	2	1	-	11
1975									
N. Milk River ab Canal	-	2	1	2	1	1	1	2	10
N. Milk R. nr Int'l B'ndry	2(1)	5	7	6	9	10	9	-	48
Milk R. @ Western X'ing	2(1)	5	2	5	1	1	1	2	19
Milk R. at Milk River	2(1)	5	2	4	1	1	1	2	18
Milk River @ Eastern X'ing	-	2	3	4	2	2	3	-	16
1976									
N. Milk R. ab Canal	1	1	1	1	1	1	1	1	8
N. Milk R. nr Int'l B'ndry	1	2	10	9	9	10	8	3	52
Milk R. at Western X'ing	1	1	1	1	1	1	1	1	8
Milk R. at Milk River	1	2	1	1	1	1	1	1	9
Milk R. at Eastern X'ing	1	3	3	2	2	3	-	-	14
1981									
N. Milk R. nr Int'l B'ndry	3	1	3	8	6	4	7	4(1)	36
Milk R. at Western X'ing	3	1	3	8	6	4	7	4(1)	36
Milk R. at Milk River	3	1	3	8	6	4	7	4(1)	36
Milk R. nr Writing-on-Stone	-	1	3	8	6	3	6	4(1)	31
Milk R. nr Pendant D'Oreille	-	2	3	8	7	4	6	4(1)	34
Milk R. at Eastern X'ing	10	16	17	13	16	16	14	5	107
1982									
N. Milk R. nr Int'l B'ndry	4	4	5	7	6	4	2	2(1)	34
Milk R. at Western X'ing	4	4	3	6	3	3	2	2(1)	27
Milk R. at Milk River	3	5	4	8	6	4	2	3(1)	35
Milk R. nr Writing-on-Stone	-	1	3	5	3	4	1	3(1)	20
Milk R. nr Pendant D'Oreille	-	1	2	4	3	7	1	3(1)	21
Milk R. at Eastern X'ing	-	3	15	16	17	9	3	5	68
1983									
Milk River @ Milk River	2	1	2	1	1	1	1	10	
1984									
Milk R. at Milk River	2	2	1	1	-	2	-	1	9
1985									
Milk R. at Milk River	1	2	1	1	2	1	-	2(1)	10

Numbers in brackets in March column are number of samples actually taken in February.
Numbers in brackets in October are number of samples actually taken in November.

Suspended sediment samples were taken by both Water Survey of Canada field technicians and by United States Geological Survey field technicians on each of their visits to the gauging station. At some sites, additional samples were taken by paid observers.

3.3 HYDRAULIC DATA

Each of the seven appendices contains hydraulic data for the specific gauge location. Included in varying detail, are data, tables and graphs of stage-discharge relations, cross-sections, specific gauge diagrams, and relationship between discharge and mean velocity in the cross-section, area of the cross-section and mean depth of the cross-section. Much of the hydraulic data were extracted from streamflow discharge measurement notes.

The stage-discharge relations for the various gauging stations are for the most part relatively unstable. In the lower portion of the basin the instability is primarily due to the movement of sand dunes through the reach. At the "North Milk River near the International Boundary" (11AA001) the stage-discharge relation has been very unstable due to meander cut-off activity, rather than due to dune progression. At the North Milk River above the Canal (11AA032) the relation has been stable due, for the most part, to the installation of a low water concrete control. Milk River @ Western Crossing (11AA025), another station which is not affected by the diversion, has been relatively stable.

The plotted cross-sections further exemplify the movement of dunes through the gauging station reaches with streambed elevation changes of 0.5 metres taking place at the mainstem Milk River stations. There does not appear to be any trend to aggradation nor to degradation at these sites, but rather the changes seem to be cyclical.

Specific gauge diagrams used in conjunction with other indicators, such as cross-section changes or stage-discharge relation changes, are good measures of aggradation or degradation of the stream bed in the vicinity of the gauging station.

The specific gauge diagram for Milk River @ Western Crossing (11AA025) (Figure C-4) gives no indication of either aggradation or degradation. The North Milk River near the International Boundary (11AA001) specific gauge diagram (Figures B-4A and B-4B) shows abrupt changes in the plot with time, paricularly in 1969 and 1972. Rather than a sudden degradation, however, these abrupt drops are associated with meander cut-offs, hence a steepening of slope and therefore more discharge occurring for the same water level. From 1915 to 1962 the average drop in the specific gauge diagram was about 0.5 metres with 0.25 metres of this taking place within six years of the beginning of the St. Mary River diversion to the Milk River.

The specific gauge diagram for Milk River at Milk River (11A005) (Figure D-4) is very flat (less than 0.1 metre fluctuation) indicating that no aggradation or degradation is taking place. The specific *gauge diagram* at Milk River at Eastern Crossing (11AA031) (Figure G-4) varies much more (0.3 metre variation) than that at Milk River and the time plot (from 1917 to 1966) shows a reduction of 0.15 metres. This indicates that there may be some distinct trend in the changes to the stream bed (or banks); either degradation or general widening. Possibly, however, with further monitoring, this may simply be a trough in a longer cycle and hence the long-term trend may be equilibrium.

At each gauging station site hydraulic data were extracted from high water streamflow discharge measurements. These data include cross-sectional area, mean-velocity in the cross-section, and the mean depth of the cross-section. These data were listed in tabular form and each was subsequently plotted versus discharge. Both the tabular data and individual plots are located in each of the appendices.

These data are highlighted by extracting the pertinent value at specific discharges for each station and then detailing them in tabular form in Table 6, which follows. This table also contains data on bank full discharge and slopes for a number of the stream gauging locations. These data are 1979 values which were extracted from the report by McLean and Beckstead (1981).

TABLE 6

HYDRAULIC DATA AT VARIOUS FLOWS FOR THE MAINSTEM GAUGING STATIONS DERIVED FROM HIGH WATER STREAMFLOW DISCHARGE MEASUREMENTS

STATION	Bank* Full Discharge m^3/s	Slope	Width (m)			Mean Depth (m)			Area (m^2)			Mean Velocity(m/s)		
			At 20 m^3/s	At 50 m^3/s	Bank Full m^3/s	At 20 m^3/s	At 50 m^3/s	Bank Full m^3/s	At 20 m^3/s	At 50 m^3/s	Bank Full m^3/s	At 20 m^3/s	At 50 m^3/s	Bank Full m^3/s
North Milk R. above Canal														
North Milk R. nr Int'l B'ndry	83.0	0.0035	24	27		0.7	1.2		17	32		1.2	1.6	
Milk R. @ Western Crossing			22	28		0.9	1.1		20	31		1.0	1.5	
Milk R. @ Milk River	104.0	0.0013	28	34	49	0.9	1.3	1.6	25	44	78	0.8	1.1	1.4
Milk R. nr Writing-on-Stone			33	37		0.9	1.5		30	56		0.7	0.9	
Milk R. nr Pendant D'Oreille			41	45		0.7	1.0		29	45		0.7	1.1	
Milk R. @ Eastern Crossing	260.0	0.00055	43	47	52	0.6	0.9	2.1	26	42	110	0.8	1.2	2.4

* - Bank full discharge and slope as defined by McLean & Beckstead (1981).

3.4 SUSPENDED SEDIMENT PARTICLE SIZE DATA

At each site where a suspended sediment program is conducted, whether a miscellaneous or full program, a number of the samples are analyzed for particle size distribution, as well as for concentration analysis. The determination as to whether a particle size analysis is to be performed is left to the discretion of the laboratory technician and the decisions are based on the available sediment materials in the sample (N.B. If the concentrations are low, less than 300 mg/L, insufficient material is available to analyze for particle sizes using standard sediment laboratory techniques.), and the number of samples at the site which have previously been analyzed for particle size data.

Table 7 lists the number of suspended sediment particle size analyses which have been performed at each site and summarizes the information for each site. The actual data for each station can be found in the respective appendix.

TABLE 7

SUSPENDED SEDIMENT PARTICLE SIZE INFORMATION

STATION	Number of Samples	Range of Sample Flows $m/^3$		D50 (mm)			Grading $(D84/D16)^{1/2}$		Mean Percent of		
		Max.	Min.	Mean	Max.	Min.	Max.	Min.	Sand	Silt	Clay
N. Milk R. ab. Canal	0	-	-								
N. Milk R. nr Int'l B'ndry	0	-	-								
Milk R. @ Western Crossing	1	60.8	60.8	0.018	-	-	5.4	5.4	19	61	20
Milk River @ Milk River	4	90.5	7.92	0.033	0.049	0.017	6.7	5.2	33	49	18
Milk R. @ Writing-on-Stone	4	32.5	20.2	0.034	0.072	0.018	9.9	6.2	37	43	20
Milk R. nr Pendant D'Oreille	7	41.9	22.7	0.040	0.130	0.007	7.3	3.3	35	42	23
Milk R. @ Eastern Crossing	23	46.3	1.93	0.039	0.125	0.0029	7.8	3.4	33	42	25

The limitation of analyzing only those samples with concentrations above 300 mg/L means that particle size analysis are only performed for samples taken at higher flows. In the Milk River the suspended sediment concentrations increase dramatically in the downstream direction (see Section 4) and thus much more material is available in the stream in the lower reaches, which accounts for the significantly larger number of samples analyzed for particle sizes. In the upper

Milk River concentrations are low, accounting for the dearth of samples analyzed for particle sizes. In fact, insufficient material was collected in any of the North Milk River samples to allow for any particle size analysis.

With the limited amount of data available it is very difficult to draw any conclusions on the changes in character of particle sizes through the reach, although there is an indication that the clay content of the suspended sediments is greater at the lower reach of the Milk River than in the mid and upper reaches.

3.5 BED MATERIAL DATA

Bed material samples have been collected by Water Survey of Canada at three sites along the Milk River; North Milk River near the International Boundary (11AA001), Milk River at Milk River (11AA015), and Milk River at Eastern Crossing (11AA031). In addition, L.B. Halferdahl, working for the Alberta Research Council, collected bed material samples in the major rivers of Alberta during 1956 to 1965. The data from this field program was collected and published by Shaw and Kellerhals (1982).

A total of 11 samples along the Milk River were collected by Mr. Halferdahl and the grain size variation of these samples are reproduced in Figure 4. Samples were bulk samples taken from the top

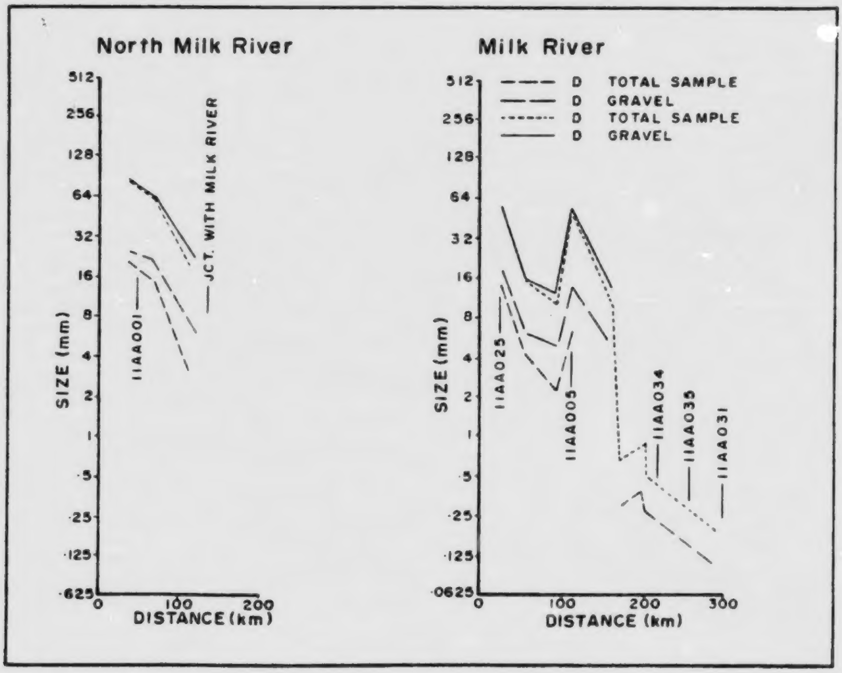

Figure 4

Bed Material Particle Size Variation Along the Milk River foot or so of the river bed. Details on sampling sites along the Milk River are reproduced in Table 8.

In 1975 two bed material samples were taken with a BMH-60 Sampler at Milk River at Eastern Crossing (11AA031). The analysis of these samples produced D50 of 0.176 mm and 0.115 mm and gradings $(D_{84}/D_{16})^{1/2}$ of 1.4 and 2.1, respectively. The results from these samples compare favorably with those found by Halferdahl. The detailed information on bed material sizes can be found in Appendix G.

Two bed material samples were taken from a side bar above the bridge crossing at Milk River at Milk River (11AA005) in October 1985. One sample was a surface sample, utilizing transect techniques (Yuzyk, 1986) and the other was a subsurface bulk sample below the upper portion of the transect line. The surface sample had a D50 of 16 mm and a grading $(D_{84}/D_{16})^{1/2}$ of 1.8. The subsurface bulk sample had a D50 of 7 mm and a grading of 2.6. Details for these samples can be found in Appendix D. Results compare favorably with Halferdahl.

TABLE 8

LOCATIONS OF BED MATERIAL SAMPLES TAKEN BY HALFERDAHL

NTS Map Sheet	Sample No / Location	Distance from Source (km)	Details of Location
82 H/2	1 2-18-1-19-W 4	127.6	River bed about 300 feet downstream from ford
82 H/1	2 8-18-2-18-W 4	155.0	River bed near left bank
82 H/1	3 15-21-2-16-W 4	196.2	Right side of bar near left bank and about 40 feet from left bank about 200 feet upstream from railway bridge
72 E/4	4 13-5-2-15-W 4	213.7	Island bar near left bank and about 40 feet from left bank
72 E/4	5 16-34-1-13-W 4	261.7	Point bar from left bank. Left bank is not marked by vegetation or change in slope here and so distance cannot be specified
72 E/4	6 3-3-2-12-W 4	273.6	Point bar about 25 feet from left bank and about 150 feet upstream from bridge
72 E/3	7 2-29-2-10-W 4	298.5	River bed about 50 feet from right bank and about 125 feet downstream from bridge
72 E/3	8 6-30-2-9-W 4	305.3	Left side of island bar near right bank, near upstream end of bar
72 E/3	9 6-3-1-5-W 4	386.1	Left bank about 200 feet upstream from under cut bank on same side of river

NORTH MILK

NTS Map Sheet	Sample No / Location	Distance from Source (km)	Details of Location
82 H/2	1 4-13-1-34-W 4	38.3	Right bank gravel which has light growth of vegetation
82 H/2	2 16-10-2-21-W 4	71.3	Right bank opposite cliff about 50 feet high on left bank. About 20 feet of gravel overlying bedrock are exposed in the cliff
82 H/1	3 8-19-2-18-W 4	119.4	Point bar 25 feet from right bank

At North Milk River near the International Boundary (11AA001) two bed material samples were also taken on October 1, 1985. As was the case at Milk River, one sample was taken from the surface by transect means, with the second being a bulk sample taken from below the surface at the upper end of the transect. These samples were taken from a side bar above the gauge. The D50 of the surface sample was 30 mm and the grading was 2.8, whereas the bulk sample D50 was 20 mm with a grading of 6.4. The sample compares favorably with Halferdahl. Details on these samples can be found in Appendix B.

3.6 DISSOLVED SOLIDS DATA

For the most part the dissolved solids information collected by Water Survey of Canada is a by-product of analyses of suspended sediment samples for either concentration or for particle size. In addition to these data, the Water Quality Branch also analyzes their samples for total dissolved solids. These data, to 1983, are contained in the report by Block (1984). Subsequent data are available upon request to the Water Quality Branch. Total dissolved solids data collected by the two agencies are compatible, as is detailed in Hamilton (1986).

These data do not provide information on specific chemical components but, by including this information with suspended sediment load and bed load, they are useful in the computation of total sediment yield. No such calculations are included in this report.

The dissolved solids concentrations ae plotted versus discharge for each gauging station. These plots are contained in each of the appendices.

3.7 BED LOAD DATA

Bed load measurements have only been made at Milk River @ Eastern Crossing (11AA031). In all, three measurements were made in 1976. The results of these measurements indicated that bed load discharge composes less than 5% of the total sediment discharge at the gauge site.

More detailed information on these measurements can be found in Appendix G.

4.0 SUSPENDED SEDIMENT LOAD

A limited amount of suspended sediment discharge data are available for sites along the reach of the Milk River. Sediment discharge data are available for North Milk River near the international Boundary (11AA001) in 1975, 1976 and 1981; for Milk River at Milk River (11AA005) in 1981 and 1982; and for Milk River at Eastern Crossing (11AA031) in 1975, 1981 and 1982. These data are shown by month, in Table 9, along with monthly mean discharges.

TABLE 9

COMPARISON OF MONTHLY SUSPENDED SEDIMENT LOAD AND MEAN MONTHLY DISCHARGES

1975

STATION	MARCH		APRIL		MAY		JUNE		JULY		AUGUST		SEPTEMBER		OCTOBER	
	Mean Q m^3/s	Total L Tonnes	Mean Q m^3/s	Total L Tonnes	Mean Q m^3/s	Total L Tonnes	Mean Q m^3/s	Total L Tonnes	Mean Q m^3/s	Total L Tonnes	Mean Q m^3/s	Total L Tonnes	Mean Q m^3/s	Total L Tonnes	Mean Q m^3/s	Total L Tonnes
N. Milk R. nr Int'l B'ndry	0.38		1.50	500	4.80	3 800	6.14	8 600	8.64	1 800	18.9	2 900	15.0	1 300	1.04	
Milk River @ Milk River	0.76		6.56		28.3		25.7		14.0		20.8		18.5		3.86	
Milk R. @ Eastern X'ing	0.46		19.0		47.0	666 000	36.2	615 000	15.8	46 000	21.9	91 000	19.6	51 000	5.15	

1981

STATION	MARCH		APRIL		MAY		JUNE		JULY		AUGUST		SEPTEMBER		OCTOBER	
	Mean Q m^3/s	Total L Tonnes	Mean Q m^3/s	Total L Tonnes	Mean Q m^3/s	Total L Tonnes	Mean Q m^3/s	Total L Tonnes	Mean Q m^3/s	Total L Tonnes	Mean Q m^3/s	Total L Tonnes	Mean Q m^3/s	Total L Tonnes	Mean Q m^3/s	Total L Tonnes
N. Milk R. nr Int'l B'ndry	11.4	3 400	10.0	700	16.7	2 500	19.5	2 700	19.8	1 700	17.5	700	15.9	780	0.79	17
Milk River @ Milk River	12.6	21 000	13.1	4 000	26.4	31 000	24.1	16 000	19.8	9 000	17.8	4 000	16.6	3 000	1.87	100
Milk R. @ Eastern X'ing	13.6	61 000	15.1	53 000	29.8	287 000	27.2	103 000	21.1	68 000	17.1	20 000	16.3	16 000	3.47	2 000

1982

STATION	MARCH		APRIL		MAY		JUNE		JULY		AUGUST		SEPTEMBER		OCTOBER	
	Mean Q m^3/s	Total L Tonnes	Mean Q m^3/s	Total L Tonnes	Mean Q m^3/s	Total L Tonnes	Mean Q m^3/s	Total L Tonnes	Mean Q m^3/s	Total L Tonnes	Mean Q m^3/s	Total L Tonnes	Mean Q m^3/s	Total L Tonnes	Mean Q m^3/s	Total L Tonnes
N. Milk R. nr Int'l B'ndry	0.82		2.59		14.8		15.4		16.5		0.45		0.38		0.42	
Milk River @ Milk River	3.66	120	20.5	87 000	20.7	22 000	20.0	10 000	18.0	9 000	0.83	14	0.57	5	1.12	14
Milk R. @ Eastern X'ing	8.65		25.8		22.6	138 000	24.8	91 000	19.3	47 000	2.19	1 000	0.69	1 400	1.25	800

As detailed earlier (Table 4) miscellaneous suspended sediment programs were carried out along the reach of the Milk River in 1974 and 1976 and from 1981 to date.

By reviewing Table 9 it readily becomes apparent that the sediment load increases dramatically from the upper reach to the lower reach of the Milk River. The most graphic illustration of this is May of 1981, when the recorded sediment discharge at North Milk River near the International Boundary was 2 500 tonnes, at Milk River @ Milk River it was 31 000 tonnes, while at Milk River at Eastern Crossing it was 287 000 tonnes. The mean flows for May for the three sites respectively, were 16.7, 26.4 and 29.8 m^3/s.

Another aspect of sediment discharge in this basin, which Table 9 highlights, is the tendency for the suspended sediment discharge to decrease with the progression of the year in spite of flows remaining fairly constant. Several examples are June to July 1975 at North Milk River near the International Boundary, when the mean monthly flow increased from 6.14 to 8.64 m^3/s, but sediment discharge decreased from 8 600 to 1 800 tonnes. Similarly, in 1982 the sediment discharge at Milk River @ Milk River from April to May dropped from 87 000 to 22 000 tonnes, but the mean monthly flow actually increased from 20.5 to 20.7 m^3/s.

Table 10, which follows, further details the loads and concentrations at various points along the Milk River. This table details the measured seasonal loads, as well as the maximum sampled suspended sediment concentrations at various sites during the sampling program. It also includes a column of simulated mean seasonal (March to October) suspended sediment discharge for the 1960 to 1985 period. The relevance and procedure for simulating these discharges will be discussed later in this section.

TABLE 10

LOADS AND CONCENTRATIONS ALONG THE REACH OF MILK RIVER

STATION	Mean Seasonal (Mar.-Oct.) Q (m^3/s)	Maximum Recorded Instantaneous Q (m^3/s)	Max. Sampled Suspended Sedimemt Concentrations (mg/L) at Corresponding Discharge (m^3/s)		Measured Seasonal Suspended Sediment Loads Tonnes			Simulated Mean Suspended Sediment Discharge 1960 to 1985
			Concentration	Discharge	1975	1981	1982	Tonnes
N. Milk River ab Canal	0.68[3]	87.5	323	8.5				700
N.Milk R.nr Int'l B'ndry	8.62	83.5	1 194	40.2	18 900[4]	12 700[2]		15 100
Milk River at Western X'ing	3.02	225.	5 229	88.9				9 700
Milk River at Milk River	12.3	260.	5 349	90.5		90 500[2]	129 000[2]	111 000
Milk R. at Writing-on-Stone	15.0[5]	94.9	1 213	32.4				
Milk R. nr Pendant D'Oreille	14.8[5]	104.	2 684	41.9				
Milk R. at Eastern Crossing	14.7	303.	12 300	174.	1 730 000[1]	612 000[2]	305 000[3]	642 000

[1] April to September
[2] March to October
[3] April to October
[4] March to September
[5] May to October

The data in Table 10 further exemplifies the large increase in sediment load in the downstream direction of the Milk River. In 1975 the seasonal load at North Milk River near the International Boundary was 18 900 tonnes, whereas at Eastern Crossing it was 1 730 000 tonnes, nearly a 100-fold increase. The south fork of the Milk River joins the north fork between these two sites, but it is evident from Table 10 that it is not a great contributor of suspended sediment (on average, approximately one-half of the north fork contribution). Similarly, from Table 10, it is evident that the greatest contribution to the suspended sediment load arises between the Town of Milk River and Eastern Crossing.

Suspended sediment rating curves have been used extensively in the computation of suspended sediment load for many years. Kellerhals et al. (1974) investigated the use of these curves as a routine procedure for Water Survey of Canada and found that the technique tended to underestimate sediment load. This finding is now widely reported (Walling, 1977) and an adjustment factor, expressed in common logarithms of exp. $(2.65S^2)$ where S is the standard error of the estimate of regression; when used, gives load estimates much closer to computed loads than does the use of unadjusted rating curves.

Monthly load data has been computed using a sediment rating curve regression equation for sites along the Milk River and the simulated data and regression plots for each site can be found in the appropriate appendix.

Having stated that simulated data is available, extreme caution should be used in utilizing these data. The simulated data are derived from simple single regression curve fits which are gross simplifications of concentration versus discharge relations, particularly where hysteresis is evident and where the flow regime is controlled.

This is particularly true for sites in the upper Milk River Basin and in fact, a standard regression equation should not be used for "North Milk River near the International Boundary". The procedure becomes somewhat more valid in the downstream direction.

In the upper reaches of the Milk River, there is an hysteresis effect where spring flows carry more sediment than do summer flows of the same magnitude. These loops diminish in the downstream direction, but are still evident even at Milk River at Eastern Crossing. Much of this loop effect can be attributed to the relatively constant summer diversion flow levels. As time progresses, less material becomes available for suspension, but the diversion effect lessens in the downstream direction. This hysteresis effect is highlighted in figures 5 and 6.

Figure 5 is a plot of the instantaneous data of suspended sediment concentration versus discharge for 1976 at North Milk River near the International Boundary. The flows for May through September remained nearly constant, but the suspended sediment concentrations drop dramatically. A single regression equation will underestimate the sediment load in the early part of the year and will overestimate the load in the latter part of the year.

Figure 6 is a plot of all the available instantaneous sampled data for Milk River at Eastern Crossing. A single regression equation for this plot fits the data better than at the North Milk River near the International Boundary, but there is still some evidence of a time-governed relationship such that a hystersis loop approach to computing suspended sediment discharge would more correctly simulate loads.

A more sophisticated procedure for calculating loads is beyond the scope of this report. All the instantaneous data and plots are contained in the appendices, which will enable those interested to try various approaches to sediment load computations.

In each of the appendices, where actual load data are available, a comparison has been made between simulated and computed seasonal loads. At the North Milk River near the International Boundary, where three years of seasonal load data are available, the simulated load data, as a percent of the computed load, varied from 42 to 131%; needless to say, a wide disparity. At Milk River at Milk River, for two years of load data, the differences were 111% and 71%, and at Milk River at Eastern Crossing the differences were 86, 96 and 186% for the three years of available load data. Monthly loads show even larger discrepancies.

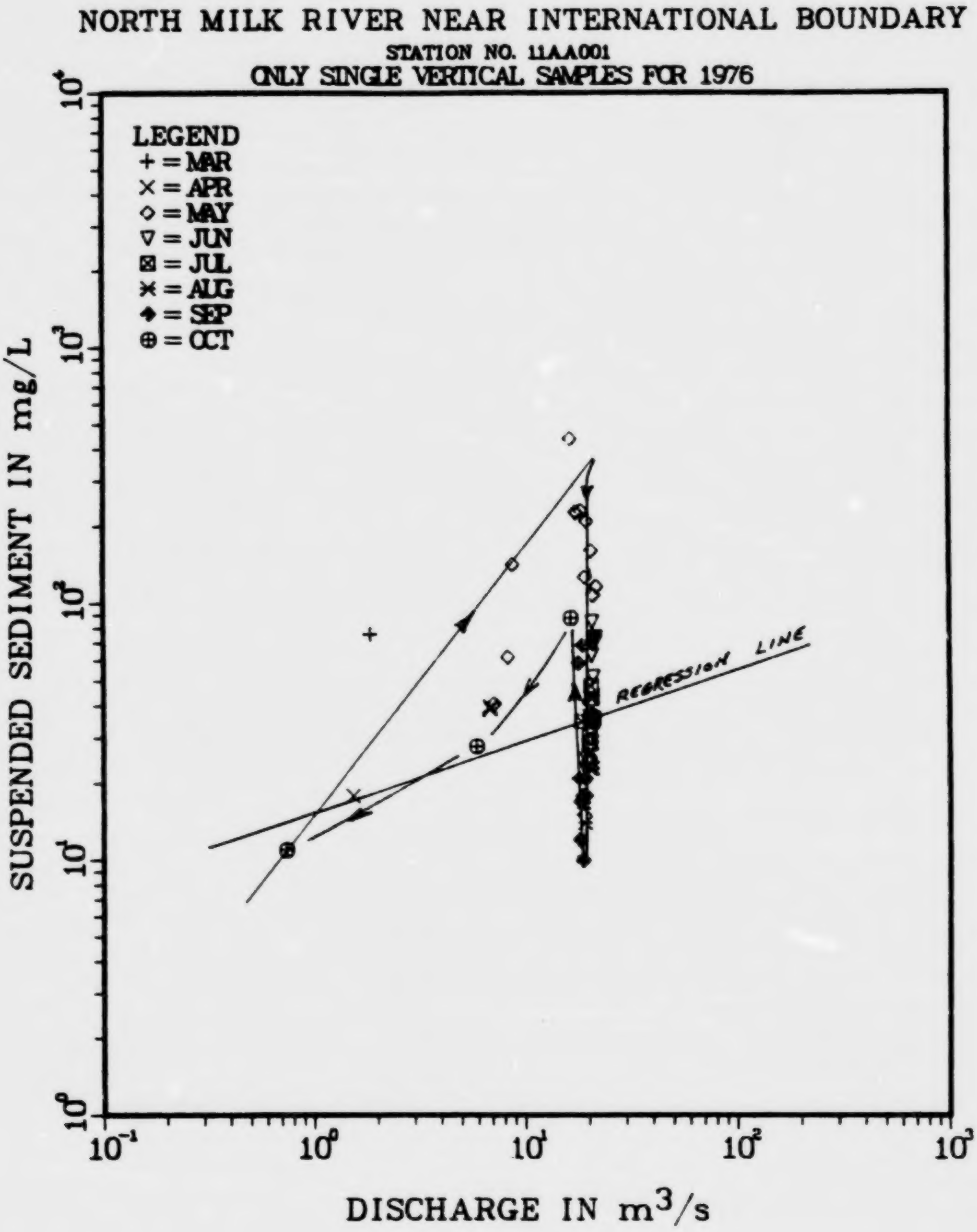

Figure 5

Plot of instantaneous suspended sediment concentration versus discharge (North Milk River near International Boundary, 1976).

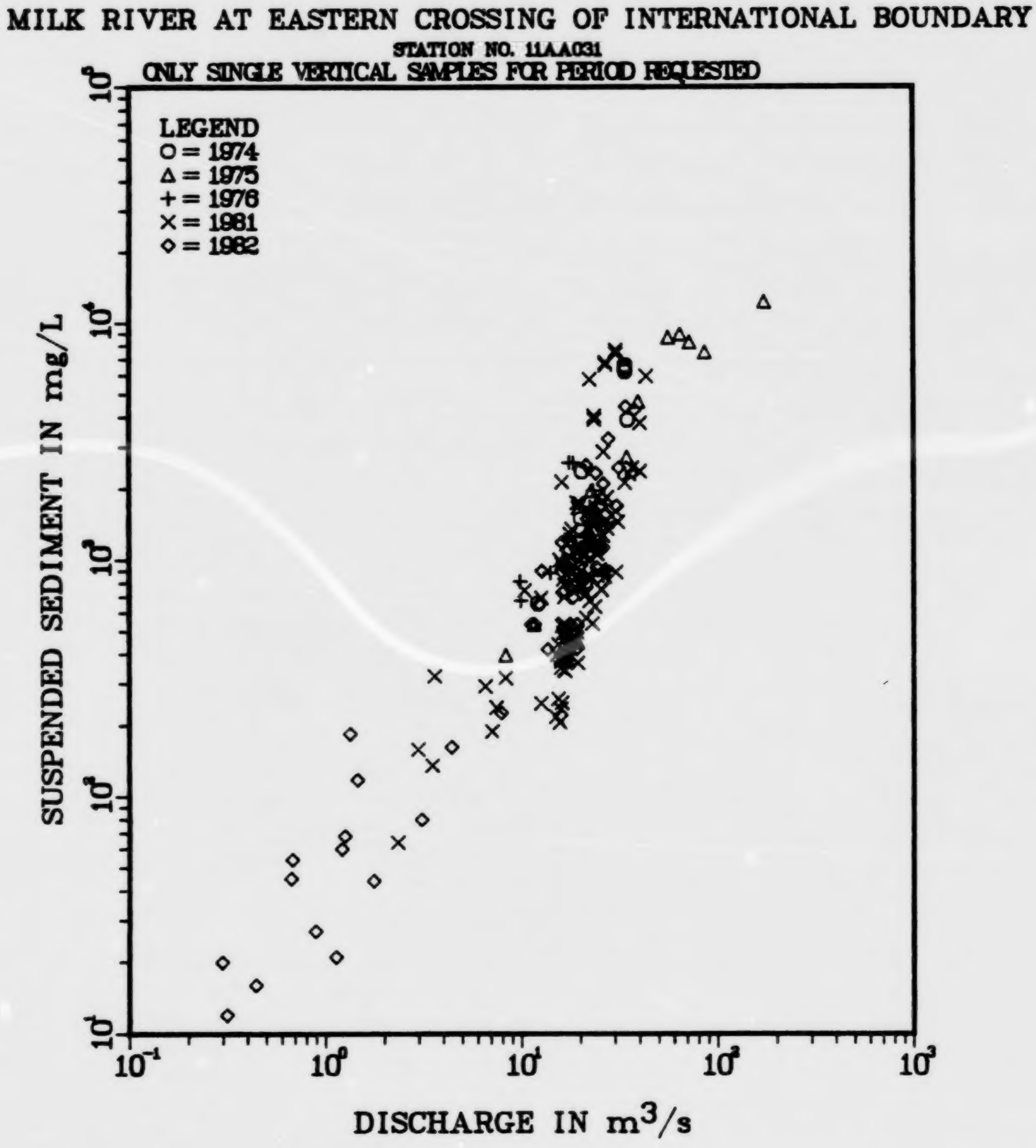

Figure 6

Plot of instantaneous suspended sediment concentrations versus discharge (Milk River at Eastern Crossing, 1974 to 1982)

5.0 DIVERSION EFFECTS

Prior to the diversion of waters from the St. Mary River through the Milk River it was recognized that the use of the natural Milk River channel as a conveyance channel would lead to river channel changes and to changes in the sediment discharges. This early recognition of a potential problem led to a 1915 pre-diversion survey of the Milk River reach under the direction of Mr. F. H. Peters, Department of the Interior. In 1979 and 1980 thirty-five of the original cross-section sites were resurveyed under the direction of Alberta Environment and Alberta Research Council. The comparison of results were reported in McLean and Beckstead, 1981 and will be listed in this section of the report and compared with the findings in this report, as related to specific gauge diagrams, cross-sectional changes and changes to hydraulic relations.

Prior to the diversion, Mr. Peters made some qualitative assessments of the changes that would take place as a result of the diversion. He concluded that the North Milk River would be running with nearly full banks, with the velocity of the stream causing very heavy scour; that, the banks being of soft material, the river channel would, in a short period of time, adapt itself to the new flow regime with a decided change in the average cross-section; and that the river would change its course in many places. He also predicted that the channel of the North Milk River would enlarge, lessening the tendency for overflow during flood events. He also predicted that the changes would be less on the Milk River than on the North Milk River, as the Milk River channel was considerably larger.

Channel widening, increased cut-off activity, and channel entrenchment along the North Milk River have been observed between 1915 and 1979, which verify Mr. Peters' predictions. The largest changes have occurred on the North Milk River along the reach from the diversion inflow to the confluence with the Milk River. McLean and Beckstead report that thirty-five cut-offs occurred in this reach between 1915 and 1979, most of which were attributed to channel enlargement, with subsequent short radius bend cut-offs. They noted that the overall length of this reach was decreased by 5.6 km and that the average bank full width increased from 19 m to 30.2 m. They also noted that there was no evidence of channel degradation (due to the coarseness of bed material). With no degradation and a shortening of the reach, the slope has been increased. Utilizing Blench's regime equations, a stable width of 32 m is predicted for a flow value of 15 m^3/s. The 1980 survey indicated an average stream width of 27 m. There is some visual evidence that channel widening has not been completed.

A gauging station, North Milk River near the International Boundary (11AA001) has been operated in this reach since 1909 and hydraulic data available from discharge measurements can be utilized to further assess the effects of the diversion. The plots for hydraulic data for this site are found in Appendix B.

Figure B-3A contains superimposed plots of four cross-sections taken at the cableway crossing from August 17, 1965 to July 16, 1985. This plot tends to confirm McLean and Beckstead's contention that the channel is still widening. The plot indicates an increase in width of about 2 metres over the twenty-one year period. In addition, the plot also indicates a trend to aggradation of the river bed.

The specific gauge diagrams (Figures B-4A and B-4B) confirm the changes taking place in the river channel with a drop of about 0.5 metres occurring from 1913 to 1962 attributable to channel wideening. Abrupt drops in the diagram in 1969 and 1972 are as a direct result of a meander cut-off occurring just below the gauging station.

Below the junction of the North Milk River with the Milk River to the site at Writing-on-Stone, McLean and Beckstead found that the increase in bank full width since the diversion was 5 to 12 metres. They also stated that there was no increase in cut-off activity in this reach.

Unfortunately, the streamflow measurement section at the gauging station Milk River at Milk River is at a highway bridge crossing with constricting piers and abutments and hence this data cannot be used to further assess channel changes. The specific gauge diagram for this site has been very flat for period of record (1922 to 1986), which indicates that very little changes occurred in the channel in the vicinity of this gauging station.

In the lower Milk River, Bradley and Smith concluded that the average channel width had not increased significantly since the diversion. McLean and Beckstead found that at eight resurveyed cross-sections in the lower reach, the average aggradation was 0.5 metres. However, viewing the specific gauge diagram for Milk River at Eastern Crossing (Figure G-4) at this specific site, there appears to have been an overall slight degradation. Aggradation/degradation in the lower Milk River appears cyclical, attributable to sand dune migration through this reach.

6.0 SUMMARY AND RECOMMENDATIONS

This report contains all readily available sediment data collected by Water Survey of Canada in a variety of tabular and graphical formats, some of which are contained in the body of the report, but the bulk of which are contained in the appendices; separated according to gauging stations. In addition to the sediment data, hydraulic data extracted from hydrometric files and notes are contained within the report and its appendices.

While it appears that sufficient data are available to make reasonable estimates of sediment loadings at various points along the Milk River's reach, these estimates must be based on procedures other than single straight line regression sediment discharge ratings. A straight regression technique produces large errors in load estimates in the Milk River system because of the strong relationship between time and load. This is particularly notable in the upper reaches of the Milk River. To produce reasonable estimates of loading, some type of hysteresis multiple regression combined with the diversion effect must be derived and applied.

Additional suspended sediment sample collection at high flows would greatly enhance the data base at each of the gauging stations on the Milk River.

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APPENDIX A

NORTH MILK RIVER ABOVE ST. MARY CANAL

11AA032

TABLE OF CONTENTS

NORTH MILK RIVER ABOVE ST. MARY CANAL

Page

1.0 HYDROMETRIC STATION DESCRIPTION A-3

1.1 Period of Record A-3
1.2 General StationDescription A-3
1.3 Channel and Valley Features A-3
Table A-1: River Valley, Flat Channel Features A-4
1.4 Stereo Pair A-5
1.5 On Site Photographs A-5

2.0 HYDRAULIC DATA A-6

2.1 Rating Curve A-6
Figure A-1: Stage-Discharge Relation A-6
2.2 Cross-Section A-6
Figure A-2: Cross-Section 50 Metres Above Gauge A-7
2.3 Specific Gauge Diagram A-7
2.4 Discharge versus Area; Mean Velocity; Mean Depth A-7

3.0 SUSPENDED SEDIMENT DATA A-8

3.1 Period of Sampling and Frequency A-8
Table A-2: Number of Suspended Sediment Samples A-8
3.2 Sampling Location, Procedures and Equipment A-8
3.3 Representativity A-8
3.4 Suspended Sediment Discharge Data A-9
Figure A-3: Sediment Discharge Rating Curve A-10
Table A-3: Simulated Suspended Sediment Load A-11

4.0 SUSPENDED SEDIMENT PARTICLE SIZE DATA A-11

5.0 BED MATERIAL DATA A-11

6.0 BED LOAD DISCHARGE DATA A-11

7.0 DISSOLVED SOLIDS DATA A-11
Figure A-4: Dissolved Solids versus Discharge A-12

DIAGRAMS AND TABLES OF DATA A-13

- Station Description A-13
- Flow Duration Curve A-14
- Streamflow and Sediment Hydrographs A-15
- Instantaneous Suspended Sediment and Dissolved Solids Data . A-17
- Suspended Sediment Rating Curves A-18

NORTH MILK RIVER ABOVE ST. MARY CANAL: 11AA032

1.0 HYDROMETRIC STATION DESCRIPTION

1.1 PERIOD OF RECORD

This gauging station was established at the present site in June 1921 and has been operated on a seasonal basis of varying months. During the latter years the seasonal operation period was April to October.

1.2 GAUGING STATION DESCRIPTION

The gauging station is located in the NE.16-37-11-WPM, Montana.

The station consists of a 1.5 metre square concrete stilling well linked to the stream by two metal intake pipes. The well is covered by a wooden walk-in shelter, which houses a float-operated Stevens A-71 strip chart water level recorder. The stage-discharge relation at most flows is controlled by a broad-crested weir located 15 metres below the gauge.

Most streamflow measurements are made by wading in the vicinity of the gauge with high flows being obtained from the bridge 1.6 km above the gauge.

A copy of the fieldman's station description can be found on page A-13.

1.3 CHANNEL AND VALLEY FEATURES

The significant features of the valley and river in the vicinity of the gauge are detailed in Table A-1. The data were extracted from aerial photographs and from a personal knowledge of the site. The classification and interpretation is based on an abbeviated form of that developed by Kellerhals et al. (1976).

TABLE A-1

NORTH MILK RIVER ABOVE ST. MARY CANAL

RIVER VALLEY, VALLEY FLAT AND CHANNEL FEATURES

GENERAL DESCRIPTION IN VINCITY OF HYDROMETRIC STATION (ABOVE VALLEY)

Terrain : Plains
Vegetation : Grass
Land Use : Partially Cultivated

VALLEY CHARACTERISTICS ABOVE VALLEY FLAT

Slumping of Valley Walls : None
Vegetation on Valley Walls : Grass

TERRACES

Presence : None
Number of Levels : Not Applicable

RELATION OF CHANNEL TO VALLEY

Valley Type : Not Applicable
Relation of Channel to Valley Bottom: Not Obviously Aggrading or Degrading
Relation of Channel to Valley Walls or Resistance Terraces : Not Applicable (no valley)

DESCRIPTION OF VALLEY FLAT

Presence : Continuous
Extent : Narrow (<one stream width)
Vegetation : Grass and Shrubs
Land Use : Not Cultivated

CHANNEL DESCRIPTION

Pattern : Tortuous Meanders
Islands : None
Bar Type : Side Bars, Mid-channel Bars
Type of Flow : Uniform with Rapids in Reach

LATERAL CHANNEL ACTIVITY

Lateral Activity : Not Detectable
Lateral Stability : Stable

CHANNEL BANK AND BEDS

Alluvial Bank Material : Clay and Silt
Bank Vegetation : Grass and Shrubs
Predominant Bed Material : Sand with local gravel

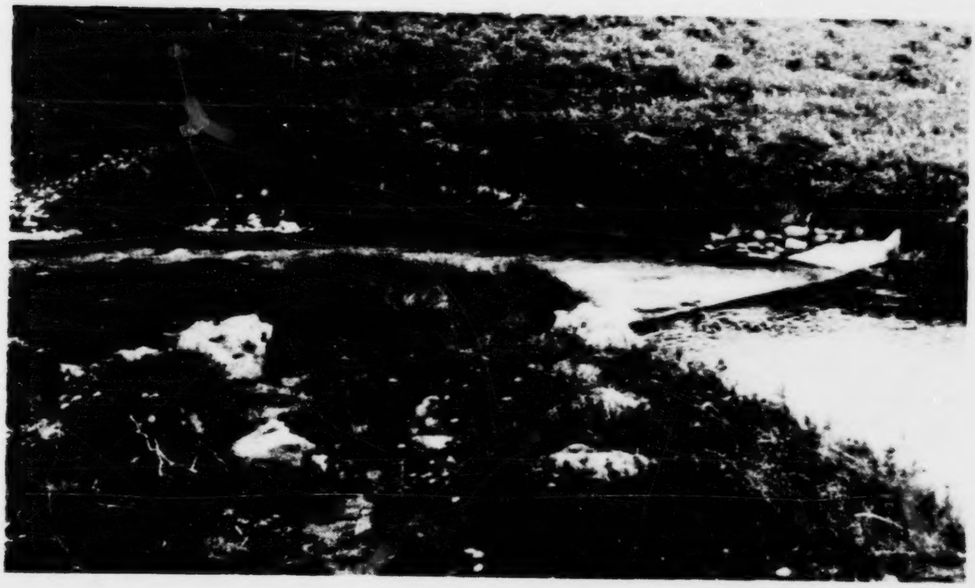
1.4 STEREO PAIR

Not available for this site.

1.5 ON SITE PHOTOGRAPHS

North Milk River above St. Mary Canal

Bridge 1000m above gauge
Looking Upstream from Right Bank
April 22, 1953



Artificial Control below Gauging Station

2.0 HYDRAULIC DATA

2.1 RATING CURVE

With the installation of the concrete control, the stage-discharge relation has been very stable and the same rating curve has been used since 1974. This curve is depicted in Figure A-1.

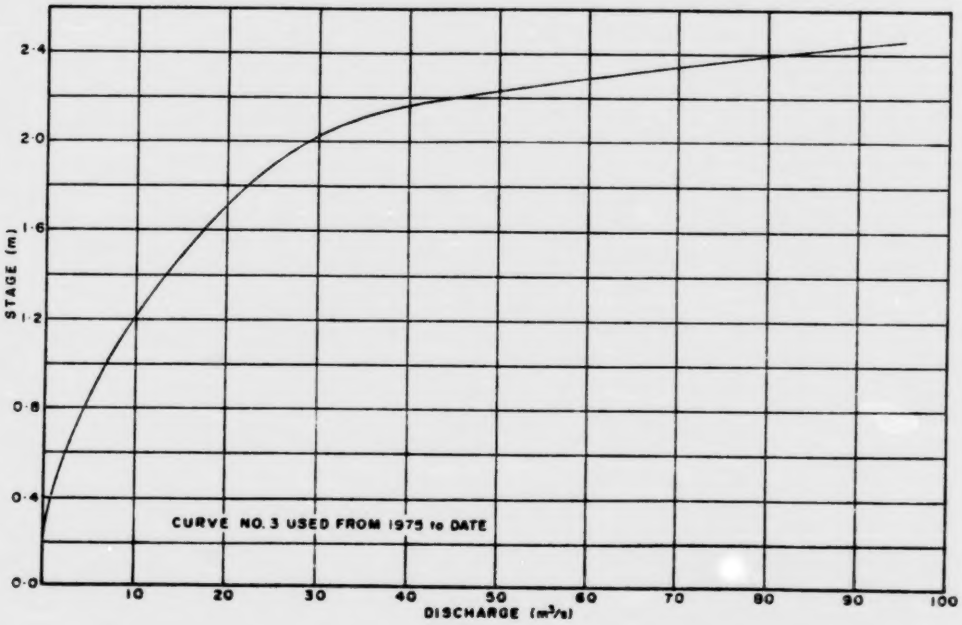


Figure A-1

Stage-Discharge Relation
North Milk River above St. Mary Canal

2.2 CROSS-SECTION

The cross-section shown in Figure A-2 is the lower cross-section of a slope-area survey used to determine the peak flow of May 8, 1967. It is located 50 metres above the gauge.

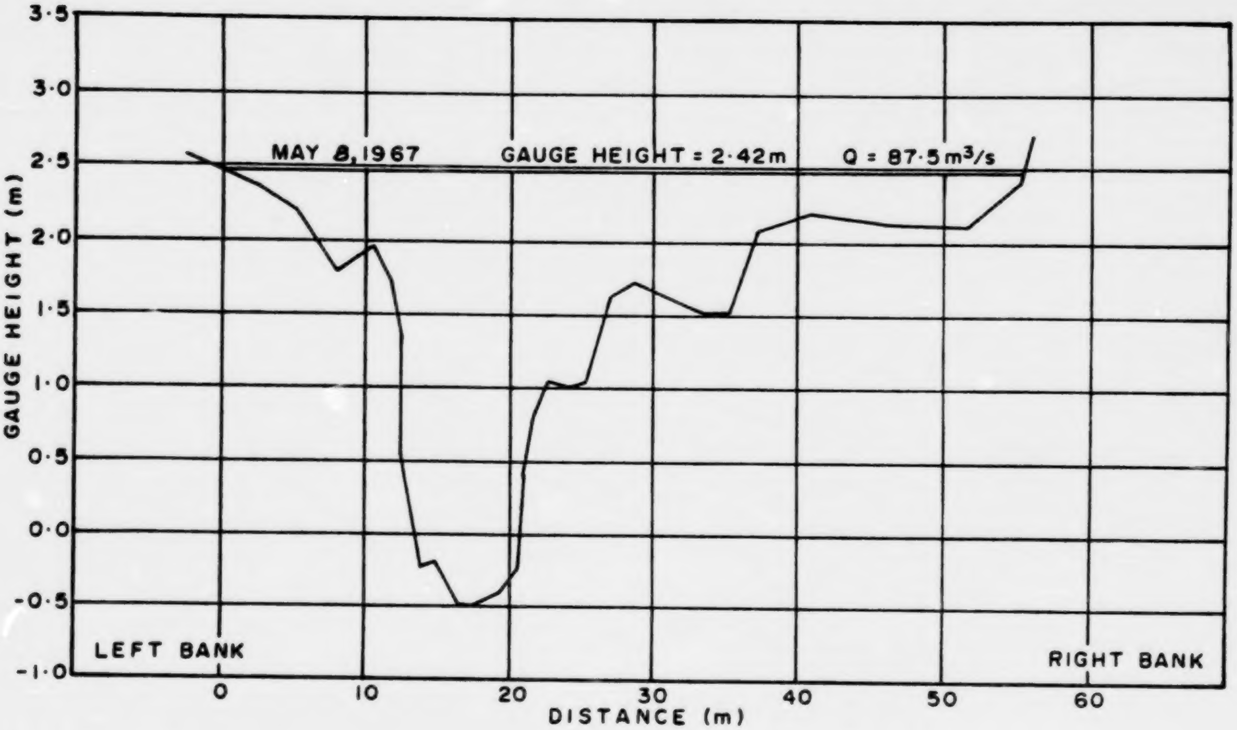


Figure A-2

Cross-Section 50 Metres Above Gauge
North Milk River above St. Mary Canal

2.3 SPECIFIC GAUGE DIAGRAM

Because of the concrete control, it would be valueless to plot a specific gauge diagram, as the control has the effect of stabilizing the bed and banks in the immediate vicinity of the gauging station. From personal knowledge of the stream, it does not appear to be aggrading nor degrading.

2.4 DISCHARGE VERSUS AREA; MEAN VELOCITY; MEAN DEPTH

Almost all streamflow discharge measurements were made by wading at various cross-sections and thus insufficient data is available to plot hydrometric curves of relation for discharge versus cross-sectional area, cross-sectional mean velocity, nor for discharge versus cross-sectional mean depth.

3.0 SUSPENDED SEDIMENT DATA

3.1 PERIOD OF SAMPLING AND FREQUENCY

A miscellaneous suspended sediment sampling program was conducted during 1974 to 1976. Samples were taken on each visit (approximately monthly intervals) to the gauging station by the field technician. The number of samples taken each month are detailed in Table A-2

TABLE A-2

NORTH MILK RIVER ABOVE ST. MARY CANAL

NUMBER OF SUSPENDED SEDIMENT SAMPLES

YEAR	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	TOTAL
1974	-	-	2	1	1	1	1	1	7
1975	-	2	1	2	1	1	1	2	10
1976	1	1	1	1	1	1	1	1	8

3.2 SAMPLING LOCATION, PROCEDURES AND EQUIPMENT

All samples were collected by wading to mid-stream utilizing a DH-48 sampler. Many of the samples were collected at the weir, but others were collected at the streamflow measurement sections, which varied, depending on flows.

3.3 REPRESENTATIVITY

Only a few samples have been collected and thus the range of discharge has not been adequately covered, nor have sufficient samples been collected to enable the computation of daily suspended sediment discharges by conventional means. The sample coverage with respect to flow range is depicted on the flow duration curve found on page A-14.

3.4 SUSPENDED SEDIMENT DISCHARGE DATA

No suspended sediment discharge data are available by conventional means, but loads have been computed using a sediment rating curve based on all the instantaneous data collected at this site. The sediment rating curve is shown in Figure A-3 and the computed data are contained in Table A-3. The data in Table A-3 should be increased by a factor of exp. $2.65s^2$, as detailed in Ashmore (1986).

Rating curves for individual years are found on pages A-18 to A-20. The instantaneous data on which these curves are based can be found on page A-17. Plots of hydrographs for the three sampled years with sample concentrations indicated, are located on pages A-15 to A-16. Page A-14 contains a flow duration curve for 1911 to 1984 with a bar graph of sample numbers at 10% flow intervals located on the bottom of this graph.

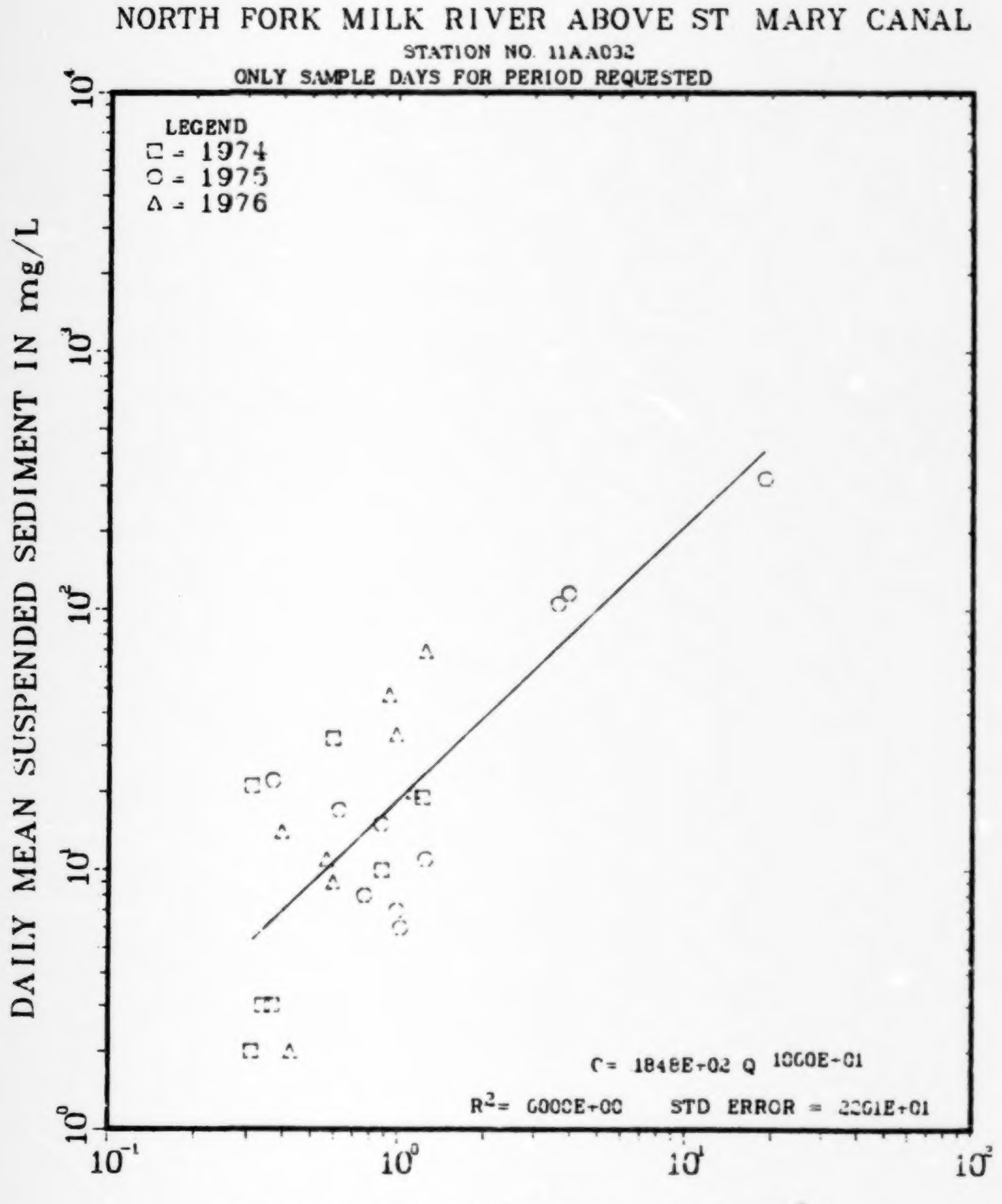


Figure A-3

Suspended Sediment Discharge Rating Curve

TABLE A-3

NORTH MILK RIVER ABOVE ST.MARY CANAL

SIMULATED SUSPENDED SEDIMENT LOAD

WATER SURVEY OF CANADA
11/03/87 PAGE 1
SEDIMENT SURVEY SECTION

NORTH FORK MILK RIVER ABOVE ST. MARY CANAL

STATION NO. 11AA032

TOTAL LOADS IN TONNES

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1960				48	52	12	6	8	7				134
1961				12	27	5	5	4	8	7			69
1962				74	16	7	4	2	4				107
1963				7	6	8	4	2	2				29
1964				48	143	300	24	16	23				555
1965				688	74	96	30	17	32	21			958
1966				46	35	212	62	36	30	40			461
1967				143	3986	123	42	29	27	30			4379
1968				41	97	72	23	15	67	39			357
1969					50	97	36	19	16	23			240
1970				104	155	57	14	10	12	17			368
1971				132	48	18	8	6	7	8			228
1972				84	125	31	16	8	10	9			282
1973				23	13	6	4	4	4	4			59
1974				71	56	16	6	8	5	5			167
1975				110	801	856	80	52	39	42			1978
1976				59	58	31	16	14	8	10			197
1977				20	9	5	4	7	6	6			56
1978				24	30	13	9	5	17	8			105
1979				160	124	33	11	10	9	11			359
1980			14	114	79	24	9	11	11	12			275
1981			16	20	90	69	26	18	17	23			280
1982					42	23	9	6	7	8			95
1983			10	8	7	4	4	2	3	3			41
1984			6	7	4	3	1	1	2	3			27
1985			13	10	12	3	1	1	4	4			48
MEAN			12	86	226	82	17	12	14	15			456
DEV.			4	137	780	173	19	12	15	13			894

4.0 SUSPENDED SEDIMENT PARTICLE SIZE DATA

No data are available.

5.0 BED MATERIAL DATA

No data are available.

6.0 BED LOAD DISCHARGE DATA

No data are available.

7.0 DISSOLVED SOLIDS DATA

Information on dissolved solids is available as a by-product of the laboratory analyses for either suspended sediment concentration or for particle sizes. A plot of dissolved solids concentration versus discharge is contained in Figure A-4 and the instantaneous data from which this plot is derived is contained on page A-17.

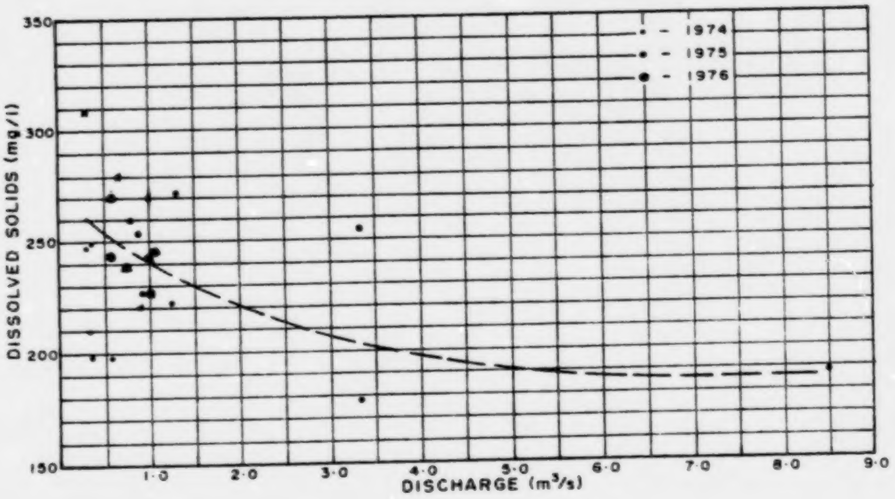


Figure A-4

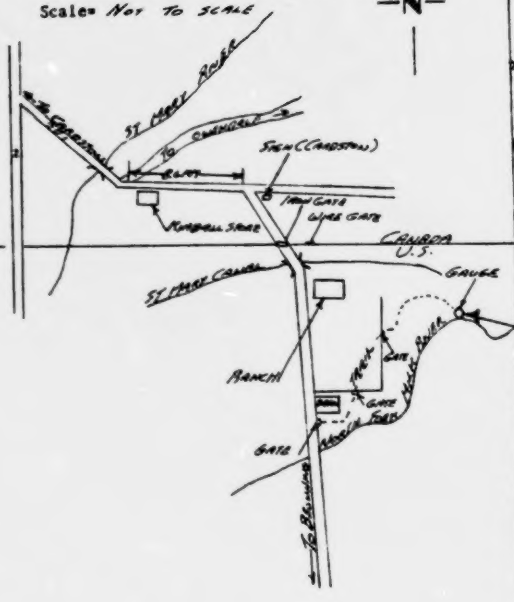
Dissolved Solids versus Discharge
North Milk River above St. Mary Canal

WATER SURVEY OF CANADA - CALGA

STATION DESCRIPTION

DETAILED SKETCH OF STATION LOCATION

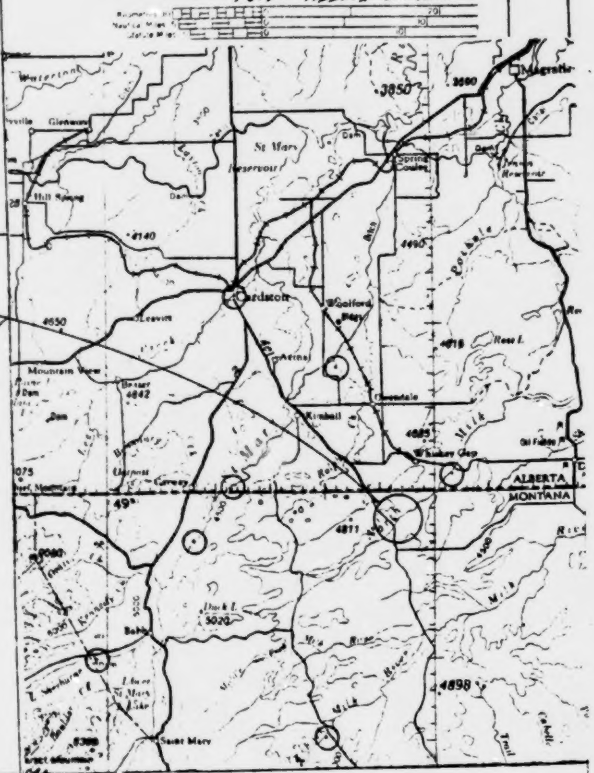
Scale= NOT TO SCALE


N
ST MARY RIVER
TO CARDSTON
TO
SIGN (CARDSTON)
IRON GATE
WIRE GATE
CANADA
U.S.
ST MARY CANAL
GAUGE
RANCH
TRAIL
GATE
GATE
NORTH FORK MILK RIVER
GATE
TO BROWNING

Intake - 6.096m long.
Elevation: -1.0 ft U.S., 28.108m Canadian.

SKETCH OF STATION LOCATION

Scale= 1. 500.000
1CM= Approx 5.1 KM.


N
Waterton
Glenwood
St Mary Reservoir
3850
Magrath
Spring Coulee
4140
Cardston
4650
Mountain View
Aetna
Kimball
Whiskey Gap
ALBERTA
MONTANA
49°
5020
4898
Saint Mary

ORIGINAL

STATION DESCRIPTION

Station No. 11AA032 Basin ______

Station Name North Fork Milk River above St. Mary Canal

Located in NE 1/4 Sec. 16 Tp. 37 Rge. 11, W.P.

Latitude 48°58'15" Longitude 113°03'19"

Established June 1921 by U.S.G.S.

Phone Canadian Customs before going to gauge (403-653-3009)

Name of Observer ______

Address ______

Rate of Pay ______ Freq. of Obs. ______

Location of station with respect to towns, etc:

From intersection of Highways #2 and #501, go southeast 19.3 km, follow road south 4.4 km to iron gate (boundary) 9.2 km south, and follow trail northeast 0.9 km to gauge.

Description of gauge and equipment:

Recorder in 1.524m square concrete well

2.560m deep

Timber shelter

2.048m I.G. (6.72 ft.)

5 ft. scale and tape gauge.

Measurement description:

Low measurements made by wading above or below the gauge.

High measurements made from bridge 1.6 km upstream.

Prepared by: RGH Date: October 17, 1983.

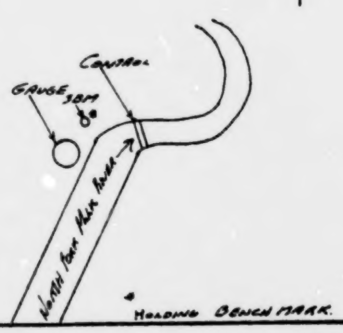
BENCH MARKS

Give elevation of bench marks, type, and number or markings, and gauge datum.

	U.S.	CANADIAN
Gauge Datum=	0.00	28.413

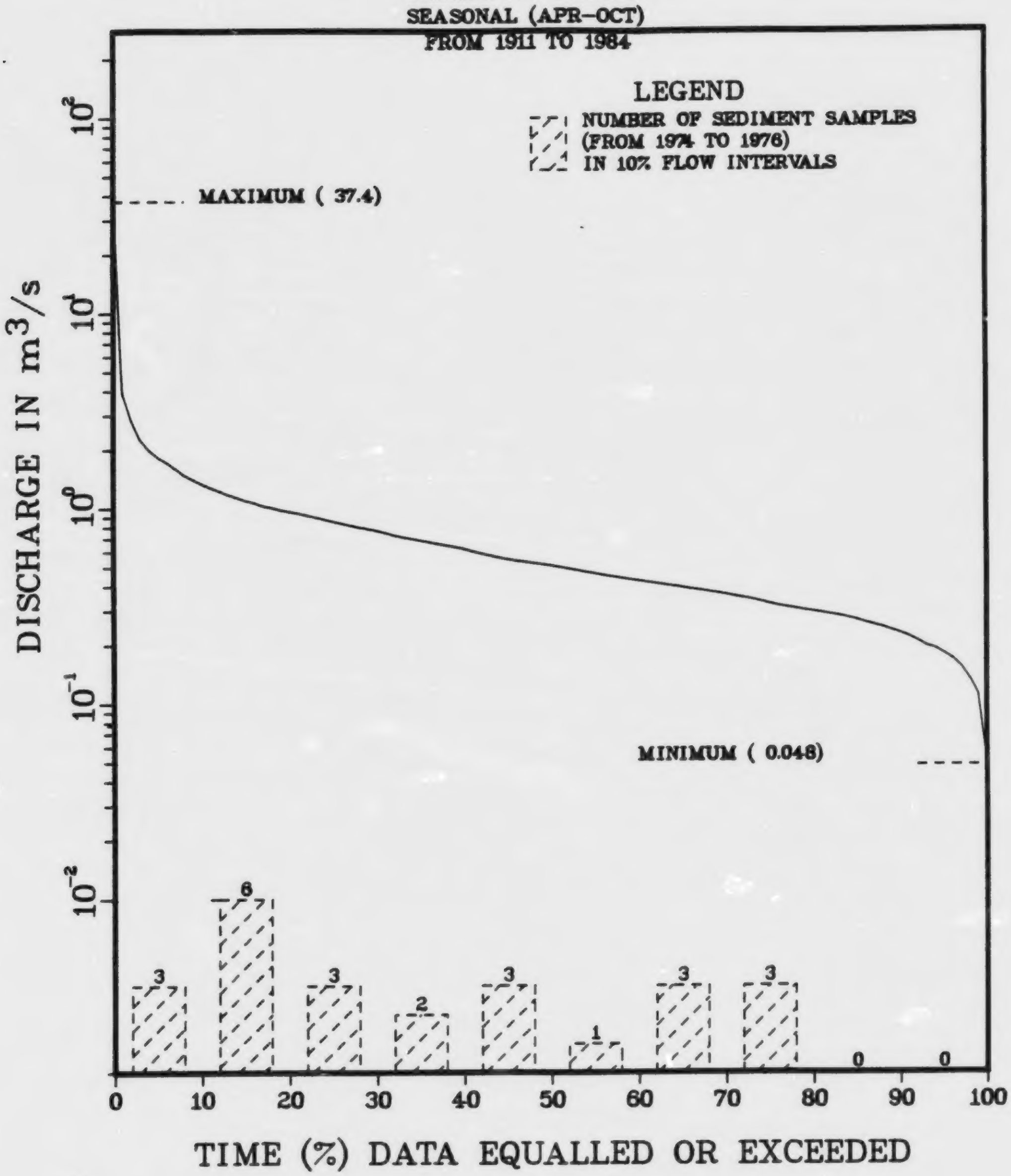
S.B.M. - 6m downstream from shelter.
Elevation: 2.082 or 30.495

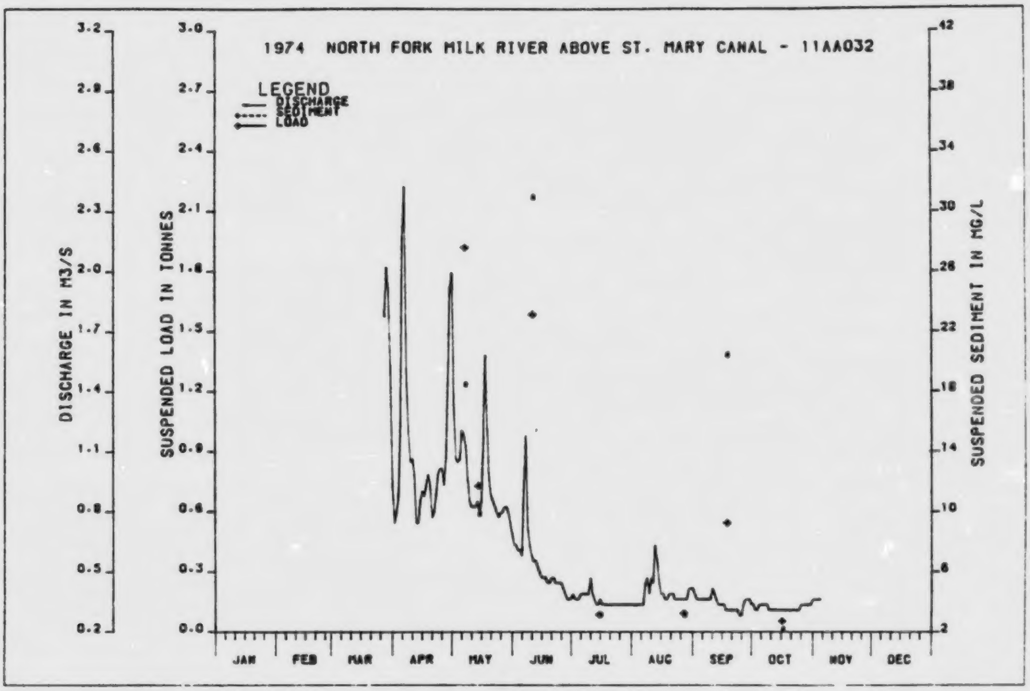
SKETCH OF BENCH MARKS

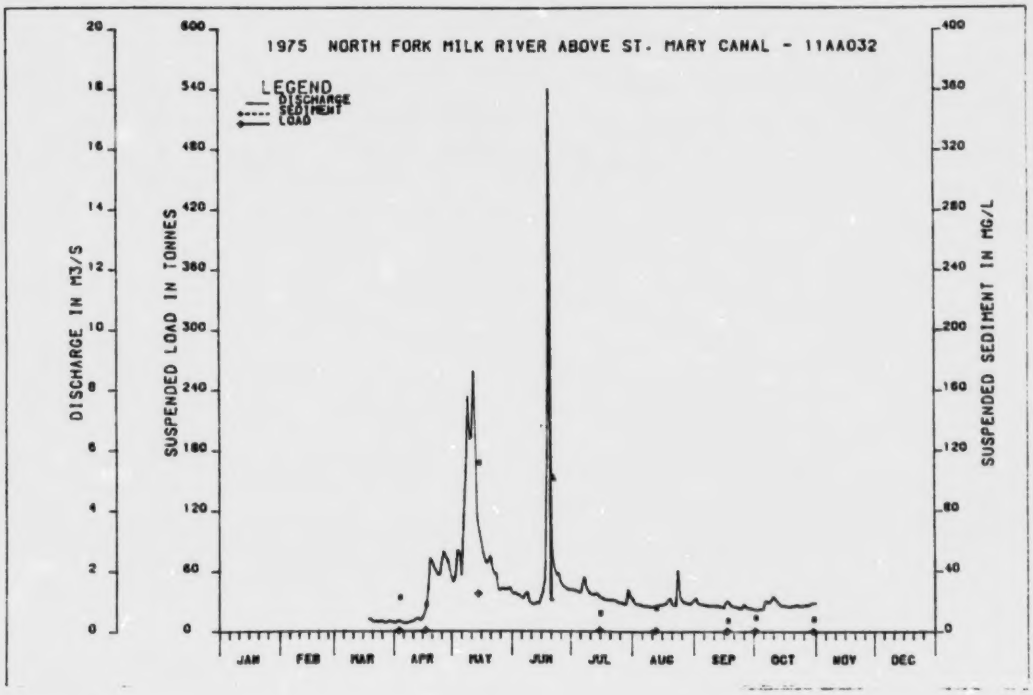

N
GAUGE
SBM
CONTROL
NORTH FORK MILK RIVER
* HOLDING BENCH MARK.

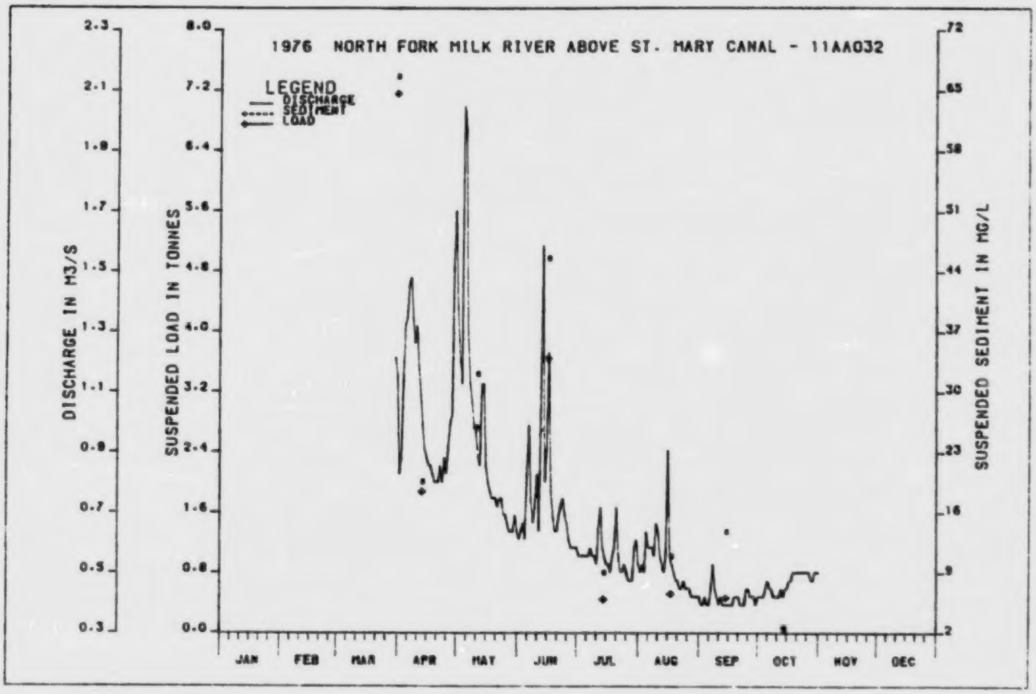
NORTH FORK MILK RIVER ABOVE ST. MARY CANAL

STATION NO. 11AA032
SEASONAL (APR–OCT)
FROM 1911 TO 1984




1974 NORTH FORK MILK RIVER ABOVE ST. MARY CANAL - 11AA032
LEGEND
DISCHARGE
SEDIMENT
LOAD
DISCHARGE IN M3/S
3.2
2.9
2.6
2.3
2.0
1.7
1.4
1.1
0.8
0.5
0.2
SUSPENDED LOAD IN TONNES
3.0
2.7
2.4
2.1
1.8
1.5
1.2
0.9
0.6
0.3
0.0
SUSPENDED SEDIMENT IN MG/L
42
38
34
30
26
22
18
14
10
6
2
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC

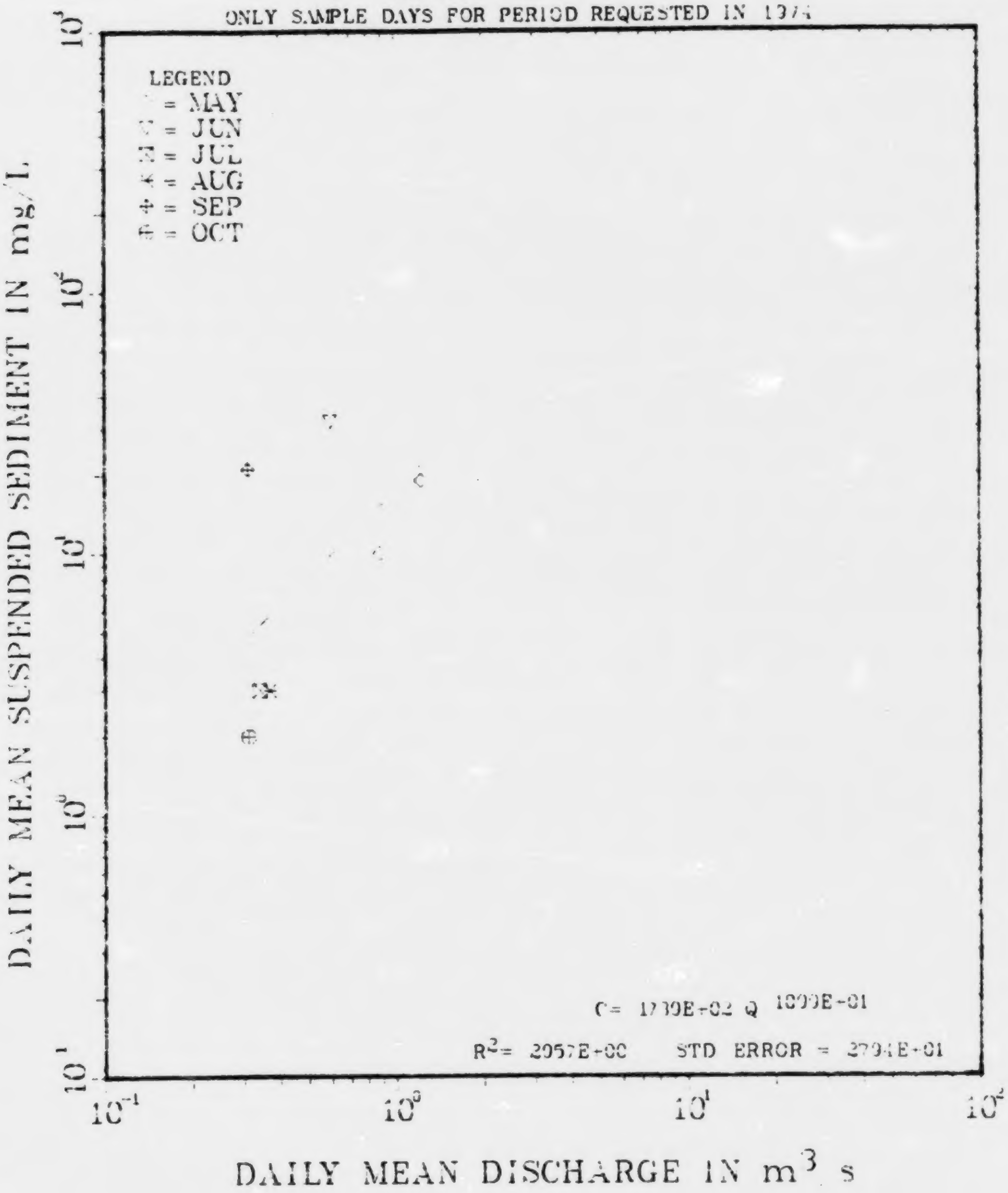

1975 NORTH FORK MILK RIVER ABOVE ST. MARY CANAL - 11AA032
LEGEND
DISCHARGE
SEDIMENT
LOAD
DISCHARGE IN M3/S
20
18
16
14
12
10
8
6
4
2
0
SUSPENDED LOAD IN TONNES
600
540
480
420
360
300
240
180
120
60
0
SUSPENDED SEDIMENT IN MG/L
400
360
320
280
240
200
160
120
80
40
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC


1976 NORTH FORK MILK RIVER ABOVE ST. MARY CANAL - 11AA032
LEGEND
DISCHARGE
SEDIMENT
LOAD
DISCHARGE IN M3/S
2.3
2.1
1.9
1.7
1.5
1.3
1.1
0.9
0.7
0.5
0.3
SUSPENDED LOAD IN TONNES
8.0
7.2
6.4
5.6
4.8
4.0
3.2
2.4
1.6
0.8
0.0
SUSPENDED SEDIMENT IN MG/L
72
65
58
51
44
37
30
23
16
9
2
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC

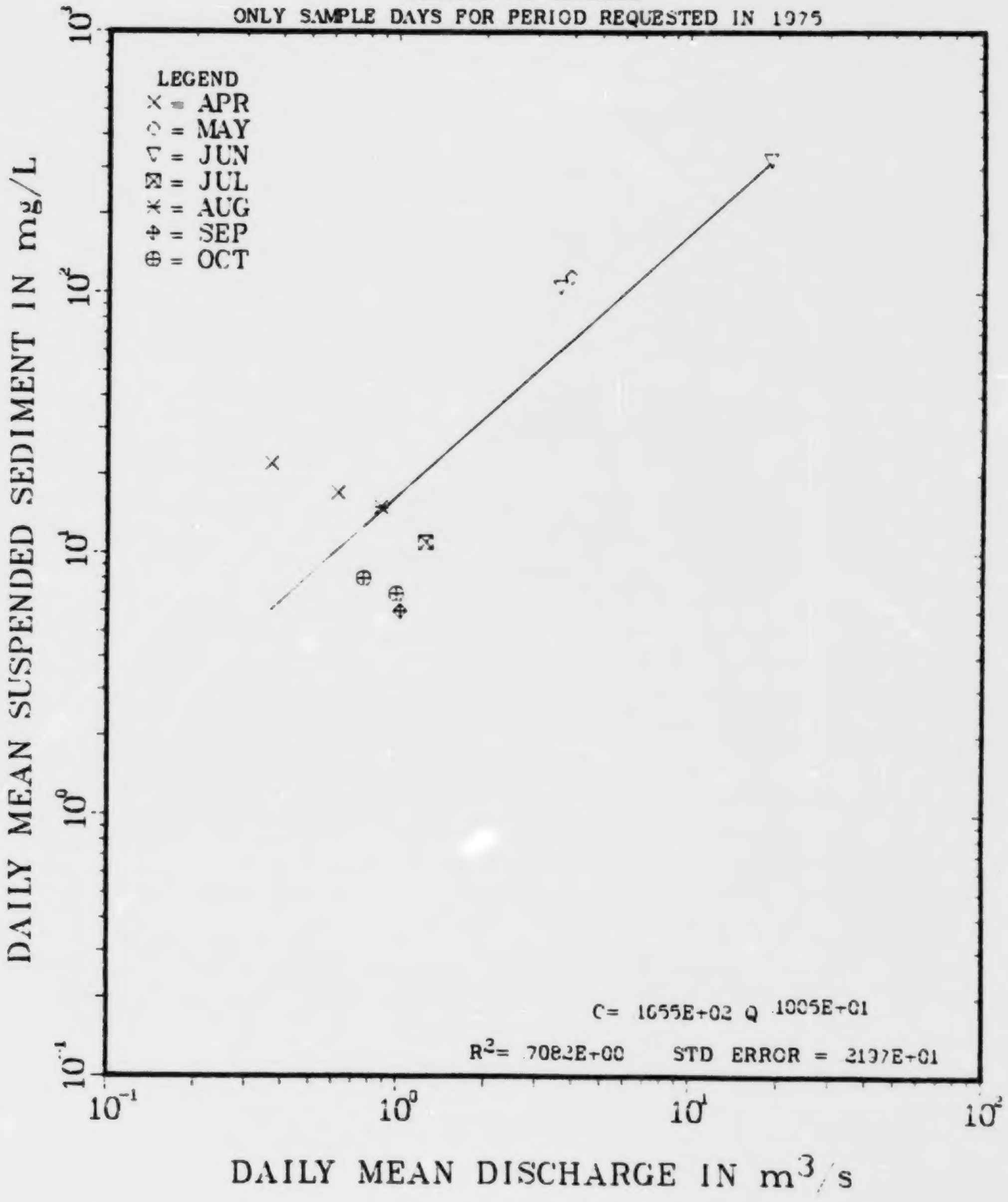
NORTH FORK MILK RIVER ABOVE ST. MARY CANAL

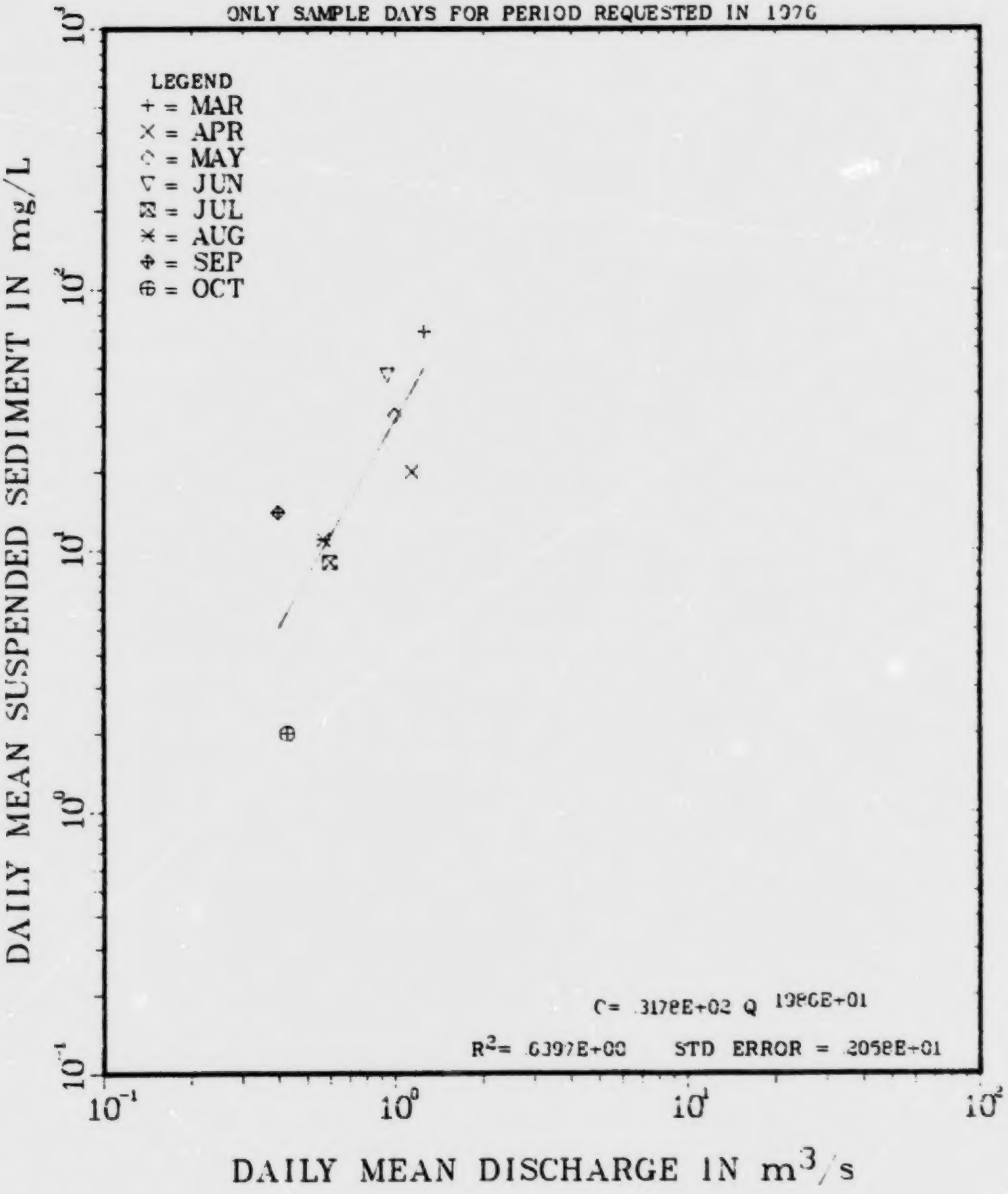
MONTH	DAY	TIME	DISSOLVED SOLIDS (mg/L)	INSTANTANEOUS CONCENTRATION (mg/L)	DISCHARGE (m^3/s)
INSTANTANEOUS DATA FOR 1974					
MAY	7	1145	222	19	1.22
MAY	14	1445	221	10	0.898
JUN	11	1210	198	32	0.569
JUL	15	1730	249	3	0.354
AUG	27	0940	198	3	0.331
SEP	18	1515	210	21	0.314
OCT	16	1700	247	2	0.306
INSTANTANEOUS DATA FOR 1975					
APR	3	1100	308	22	0.326
APR	17	1400	229	17	0.654
MAY	14	1510	177	115	3.34
JUN	20	1850	189	323	8.50
JUN	21	1500	255	105	3.34
JUL	15	1345	271	11	1.30
AUG	12	1550	227	15	0.909
SEP	17	0900	254	6	0.883
OCT	1	1700	260	8	0.779
OCT	30	1310	270	7	1.00
INSTANTANEOUS DATA FOR 1976					
MAR	31	1220	227	69	1.00
APR	13	1310	246	20	1.06
MAY	11	1900	243	33	0.988
JUN	16	0820	239	47	0.688
JUL	14	1330	270	9	0.569
AUG	17	1630	243	11	0.555
SEP	14	1515	–	14	0.402
OCT	14	1110	–	2	0.439

NORTH FORK MILK RIVER ABOVE ST MARY CANAL
STATION NO 11AA032
ONLY SAMPLE DAYS FOR PERIOD REQUESTED IN 1974



NORTH FORK MILK RIVER ABOVE ST MARY CANAL
STATION NO. 11AA032
ONLY SAMPLE DAYS FOR PERIOD REQUESTED IN 1975





NORTH FORK MILK RIVER ABOVE ST MARY CANAL

STATION NO 11AA032

ONLY SAMPLE DAYS FOR PERIOD REQUESTED IN 1976

APPENDIX B

NORTH MILK RIVER NEAR INTERNATIONAL BOUNDARY

11AA001

TABLE OF CONTENTS

NORTH MILK RIVER NEAR INTERNATIONAL BOUNDARY

Page

1.0 HYDROMETRIC STATION DESCRIPTION B-4

- 1.1 Period of Record B-4
- 1.2 Gauging Station Description B-4
- 1.3 Channel and Valley Features B-4
  - Table B-1: River Valley, Flat and Channel Features B-5
- 1.4 Stereo Pair B-6
  - Figure B-1: Stereo Pair Aerial Photograph B-6
- 1.5 On Site Photographs B-7

2.0 HYDAULIC DATA B-8

- 2.1 Rating Curve B-8
  - Figure B-2: Stage-Discharge Relation B-8
- 2.2 Cross-Section B-9
  - Figure B-3A: Cross-Section Beneath Cableway B-9
  - Figure B-3B: Cross-Section Beneath Cableway (Slope Area) B-10
- 2.3 Specific Gauge Diagram B-11
  - Figure B-4A: Specific Gauge Diagram (1913 to 1962) B-11
  - Figure B-4B: Specific Gauge Diagram (1962 to 1985) B-12
- 2.4 Discharge versus Area; Mean Velocity; Mean Depth B-12
  - Figure B-5: Discharge versus Area B-13
  - Figure B-6: Discharge versus Mean Velocity B-13
  - Figure B-7: Discharge versus Mean Depth B-13
  - Table B-2: Hydraulic Data @ Cableway B-14

3.0 SUSPENDED SEDIMENT DATA B-18

- 3.1 Period of Sampling and Frequency B-18
  - Table B-3: Number of Suspended Sediment Samples B-18
- 3.2 Sampling Location, Procedures and Equipment B-18
- 3.3 Representativity B-19
  - Figure B-8: Recurrence Intervals of Total Seasonal Discharge (dam^3)........................... B-19
- 3.4 Suspended Sediment Discharge Data B-20
  - Table B-4: Seasonal Suspended Sediment Load B-20
  - Figure B-9: Suspended Sediment Concentration versus Discharges B-21

4.0 SUSPENDED SEDIMENT PARTICLE SIZE DATA B-23

5.0 BED MATERIAL DATA B-23
- Figure B-10: Bed Material Data B-23

TABLE OF CONTENTS (cont'd.)

NORTH MILK RIVER NEAR INTERNATIONAL BOUNDARY

Page

6.0 BED LOAD DISCHARGE DATA B-24

7.0 DISSOLVED SOLIDS DATA B-24

DIAGRAMS AND TABLES OF DATA

- Station Description B-25
- Flow Duration Curve B-26
- Streamflow and Sediment Hydrographs B-27
- Instantaneous Suspended Sediment & Dissolved Solids Data B-30
- Published Sediment Data B-36
- Annual Suspended Sediment Rating Curve B-42
- Dissolved Solids versus Discharge Plots B-47

NORTH MILK RIVER NEAR INTERNATIONAL BOUNDARY: (11AA001)

1.0 HYDROMETRIC STATION DESCRIPTION

1.1 PERIOD OF RECORD

This station was established in July 1909 in the NE.13-1-23-W4. In June 1913 the station was relocated 3 kilometres upstream to NE.11-1-23-W4. In April 1930 it was again relocated, but only moved 30 metres downstream. The final move of this station took place in September 1962 to a site 1 100 metres upstream and is now situated in NE.11-1-23-W4 .

For the most part, this station has been operated on a seasonal basis (March to October) except that in 1913 to 1922 the station was operated on a year round basis.

1.2 GAUGING STATION DESCRIPTION

The present gauging station is located on the right bank, some 1 100 metres above Highway No. 501 bridge crossing.

The station consists of a 1.5 metre wood stave culvert stilling well linked to the stream by two metal intake pipes. The well is covered by a standard walk-in shelter which houses a float-activated A-71 Stevens strip chart water level recorder.

High water measurements (>10 m^3/s) are made from a cableway located 30 metres above the gauge. Other flows are metered by wading in the vicinity of the gauge.

A copy of the fieldman's description can be found on page B-26.

1.3 CHANNEL AND VALLEY FEATURES

The significant features of the valley and river in the vicinity of the gauge are detailed in Table D-1, the data for which were extracted from aerial photographs and from a personal knowledge of the site. The classification and interpretation is based on an abbreviated form of that developed by Kellerhals et al. (1976).

TABLE B-1

NORTH MILK RIVER NEAR INTERNATIONAL BOUNDARY

RIVER VALLEY, VALLEY FLAT AND CHANNEL FEATURES

GENERAL DESCRIPTION IN VINCITY OF HYDROMETRIC STATION (ABOVE VALLEY)	
Terrain	: Plains
Vegetation	: Grass
Land Use	: Partially Cultivated
VALLEY CHARACTERISTICS ABOVE VALLEY FLAT	
Slumping of Valley Walls	: None
Vegetation on Valley Walls	: Grass
TERRACES	
Presence	: Fragmentary
Number of Levels	: Several Levels
RELATION OF CHANNEL TO VALLEY	
Valley Type	: Stream Cut Valley
Relation of Channel to Valley Bottom	: Not Obviously Aggrading or Degrading
Relation of Channel to Valley Walls or Resistance Terraces	: Frequently Cultivated
DESCRIPTION OF VALLEY FLAT	
Presence	: Fragmentary
Extent	: Moderate (1 to 5 channel widths)
Vegetation	: Grass and Shrubs
Land Use	: Not Cultivated
CHANNEL DESCRIPTION	
Pattern	: Irregular
Islands	: None
Bar Type	: Point Bars
Type of Flow	: Uniform with Rapids in Reach
LATERAL CHANNEL ACTIVITY	
Lateral Activity	: Progression and Cut-offs
Lateral Stability	: Moderately Unstable
CHANNEL BANK AND BEDS	
Alluvial Bank Material	: Gravel Overlain by Silt
Bank Vegetation	: Grass
Predominant Bed Material	: Gravel

1.4 STEREO PAIR

Figure B-1 is a stereo pair of the present gauging station site. The photos were taken in June 1985 and are at a scale of 1:30 000.

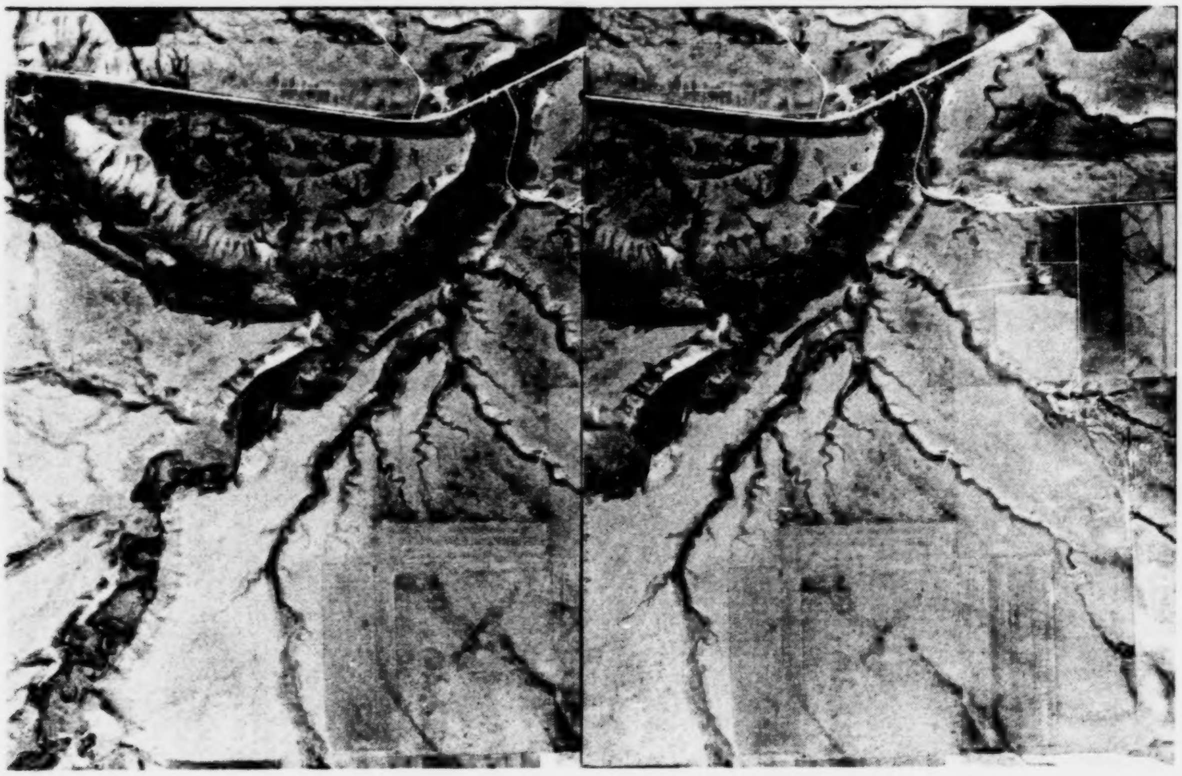
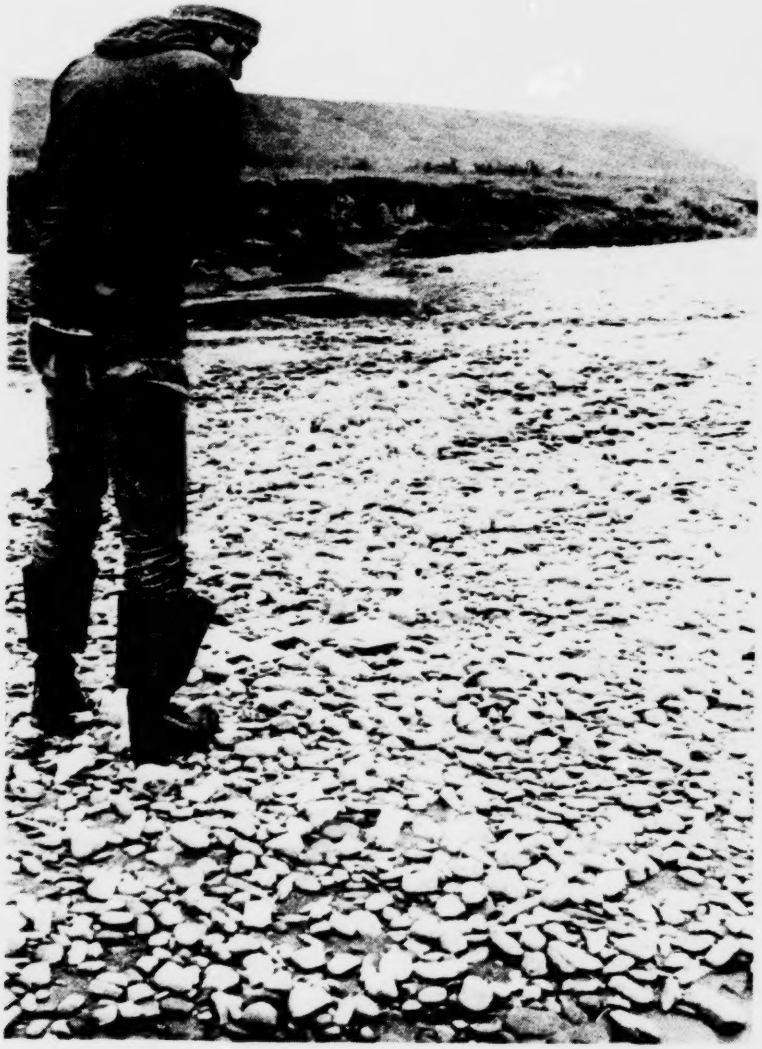


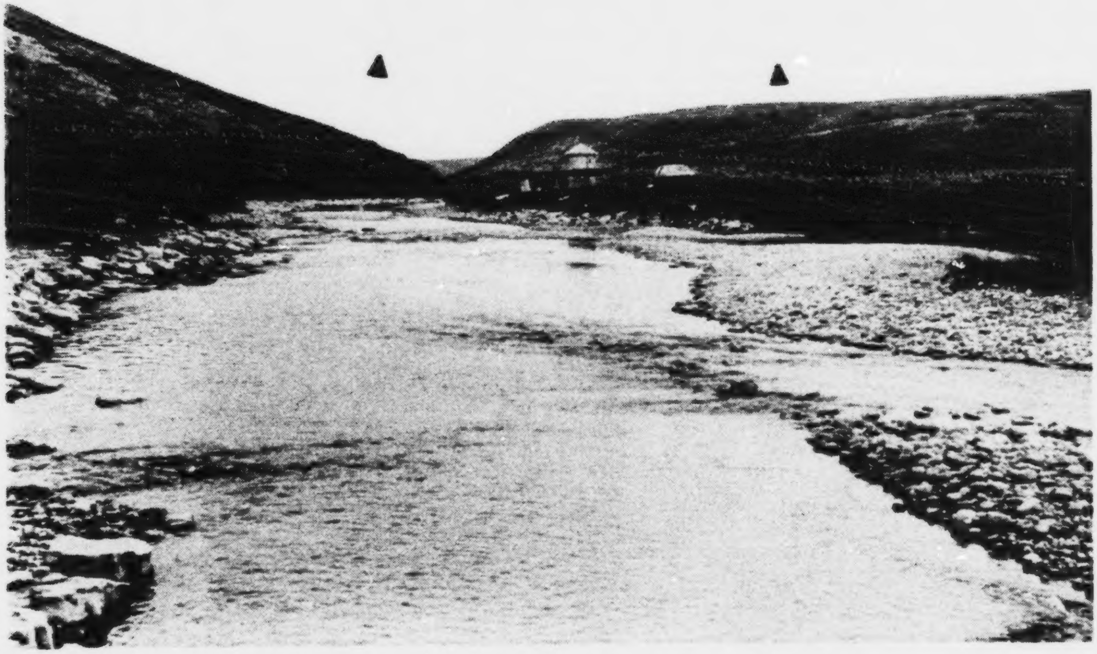
Figure B-1

Stereo Pair Aerial Photograph
Arrow Indicates Gauging Station
North Milk River near International Boundary

1.5 ON SITE PHOTOGRAPHS



North Milk River near International Boundary
Surface Bed Material Sampling Section
Side Bar 100m above Gauge



North Milk River near International Boundary
Looking Downstream towards Gauge

2.0 HYDRAULIC DATA

2.1 RATING CURVE

The stage-discharge relations since August 1962 are depicted in Figure B-2. From this figure, it is evident that the relation is unstable. A particularly large change took place in the spring of 1972, which is coincident with the stream completing the cut-off of a meander, resulting in an immediate steepening of the stream slope in the vicinity of the gauge. The curve of relation continued to shift to the right (more flow for the same gauge height), but at a decelerated rate and in fact, since 1976, the curve has nearly stabilized with only minor changes taking place.

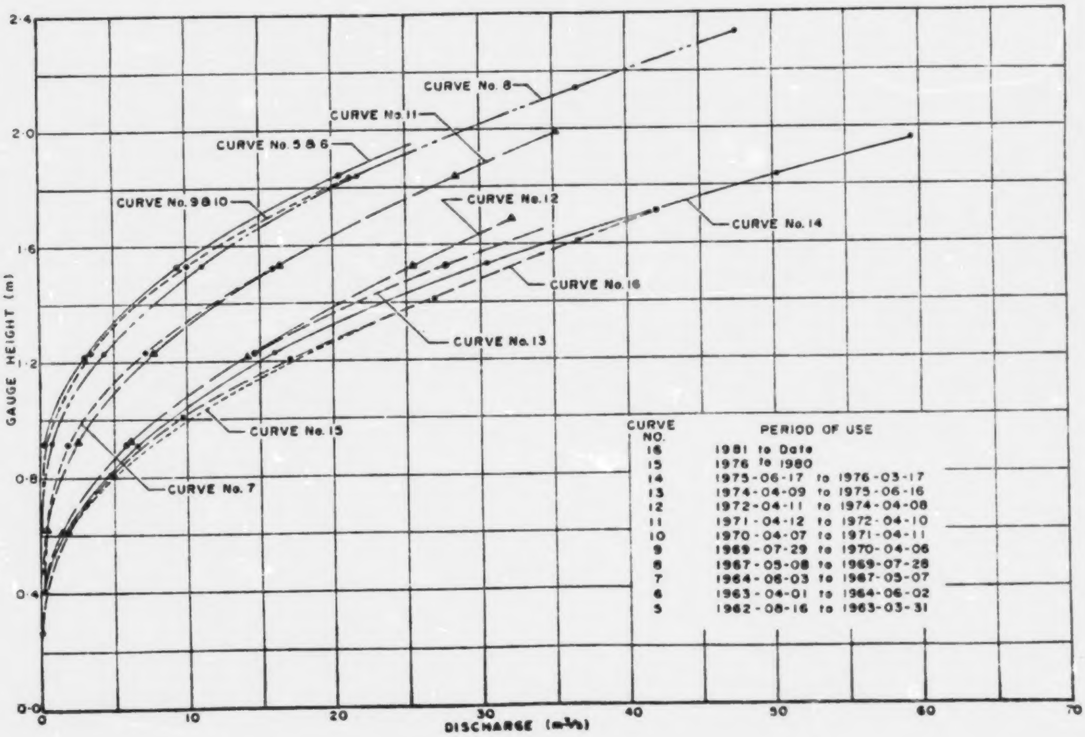


Figure B-2

Stage-Discharge Relations: 1962 to Date
North Milk River near International Boundary

2.2 CROSS-SECTIONS

The cross-sections depicted in Figure B-3A are derived from streamflow discharge measurements taken from the cableway. The cross-section depicted in Figure B-3B was a surveyed cross-section at the cableway site and was used in a slope-area determination of peak flow in June 1964.

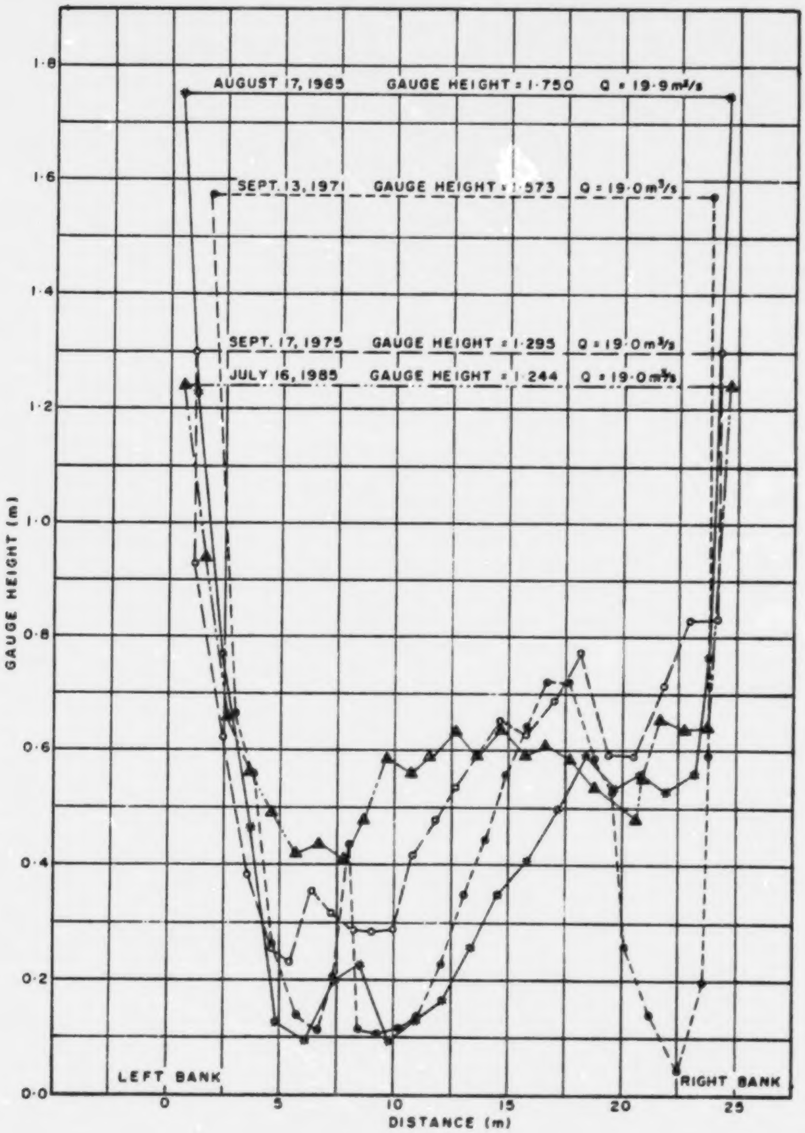


Figure B-3A

Cross-Section Beneath Cableway
North Milk River near International Boundary

From the composite plot (Figure B-3A) it can be seen that there is a movement of gravel bars through the section with a general aggradation of 0.4 metres over the past 15 to 20 years, which is anomalous when compared with the change in the stage-discharge relation.

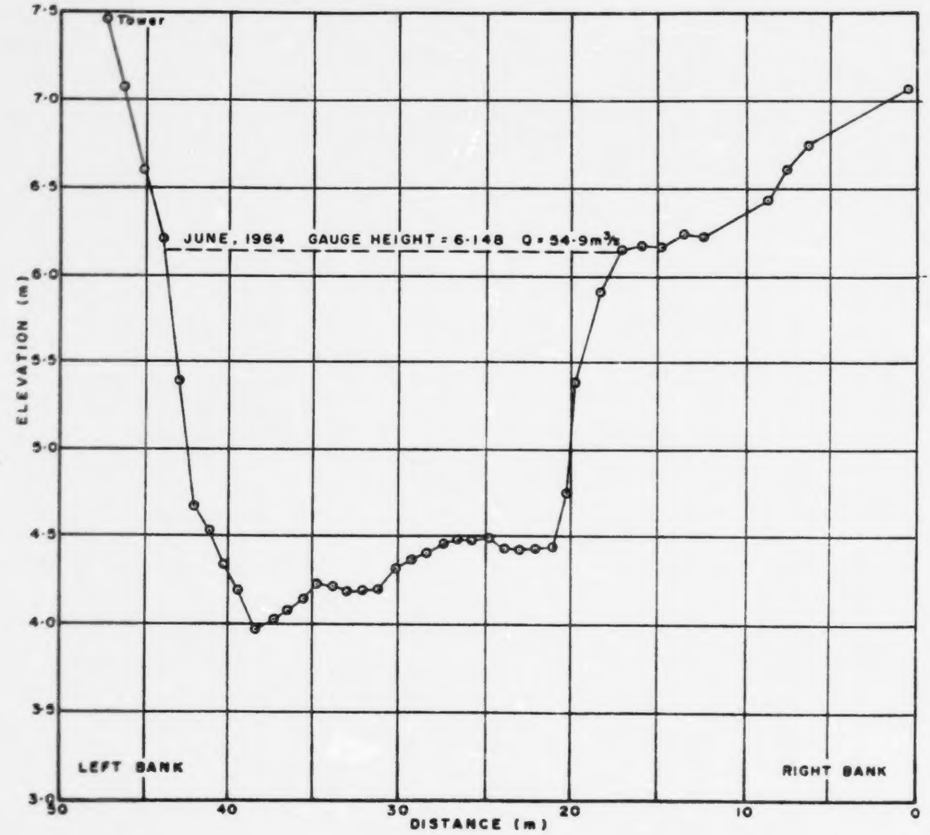


Figure B-3B

Cross-Section Beneath Cableway (Slope-Area Section)
North Milk River near International Boundary

Obviously the cut-off of the meander was much more influential in the changing of the stage-discharge curve than was the aggradation. Actually, it would be more normal for the stream bed above the gauge to be degrading to try and adjust the slope back to a "prior to cut-off slope".

2.3 SPECIFIC GAUGE DIAGRAM

Figures B-4A and B-4B are specific gauge plots for the period 1914 to 1962 and 1962 to 1985, respectively. These diagrams show the gauge heights for three different discharges (1, 10 and 20 m^3/s) as they change over the period of record. Figure B-4B is the diagram for the period of record at the present site.

From 1913 to 1962 there is a general decrease in the specific gauge values of about 0.5 metres. This is due to the general widening of the river channel as a result of the use of the North Milk River as a conveyance channel in the diversion of St. Mary River waters to the lower Milk River Basin. From 1962 to 1985 the plot is quite flat with the general exceptions of 1969 and 1972, when abrupt changes in the diagram occurred. These were attributable to a meander cut-off (a partial cut-off occurred in 1969, with the cut-off being completed from March 14 to 22, 1972).

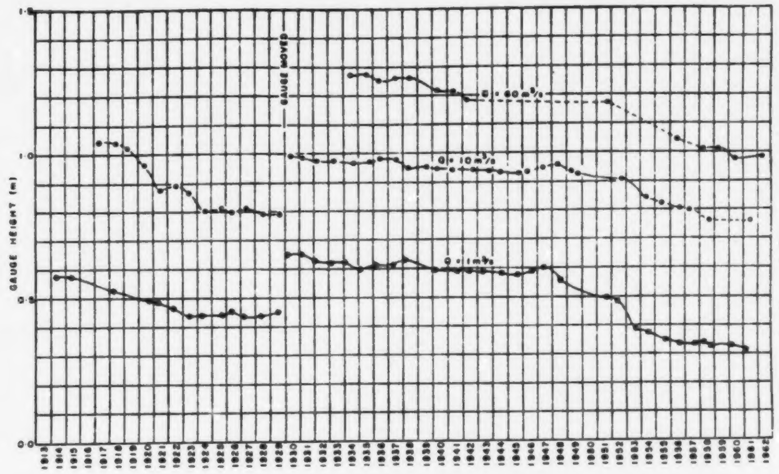


Figure B-4A:

Specific Gauge Diagram 1913 to 1962
North Milk River near International Boundary

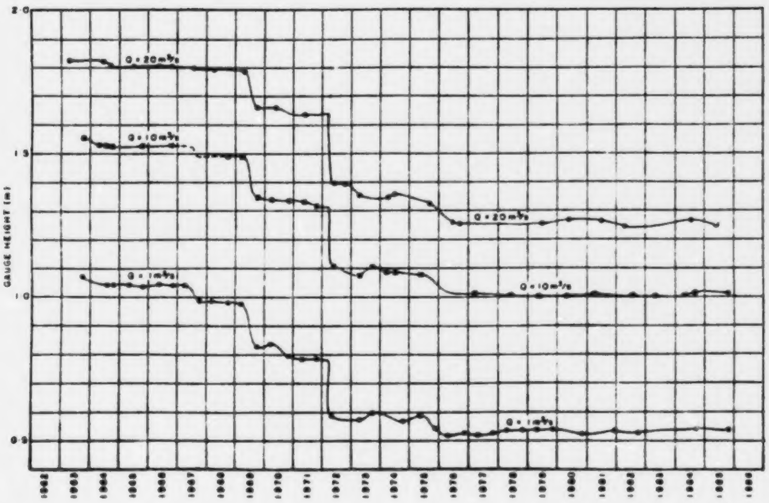


Figure B-4B:

Specific Gauge Diagram 1962 to 1985
North Milk River near International Boundary

2.4 DISCHARGE VERSUS AREA; MEAN VELOCITY; MEAN DEPTH

Plots of discharge versus cross-sectional area, discharge versus the mean velocity in the cross-section and discharge versus the mean depth of the cross-section are reproduced in Figures B-5 to B-7, respectively. The cross-section for which the hydraulic data was extracted and plotted is at the cableway crossing. The data was derived from streamflow measurements taken at this location. The data used in producing the figures are tabulated in Table B-2.

The results of the meander cut-off on these plots is immediately evident. These plots are less stable than those experienced at other sites along the Milk River reach.

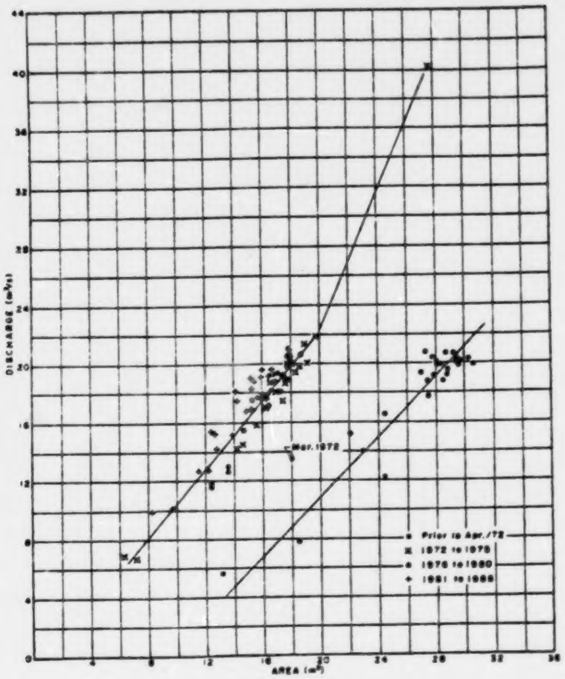


Figure B-5

Discharge Versus Cross-Sectional Area

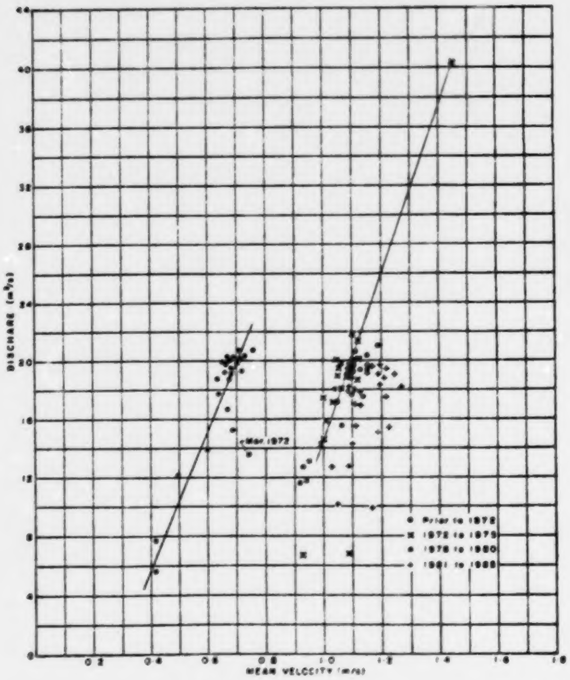


Figure B-6

Discharge versus Mean Velocity

North Milk River near International Boundary

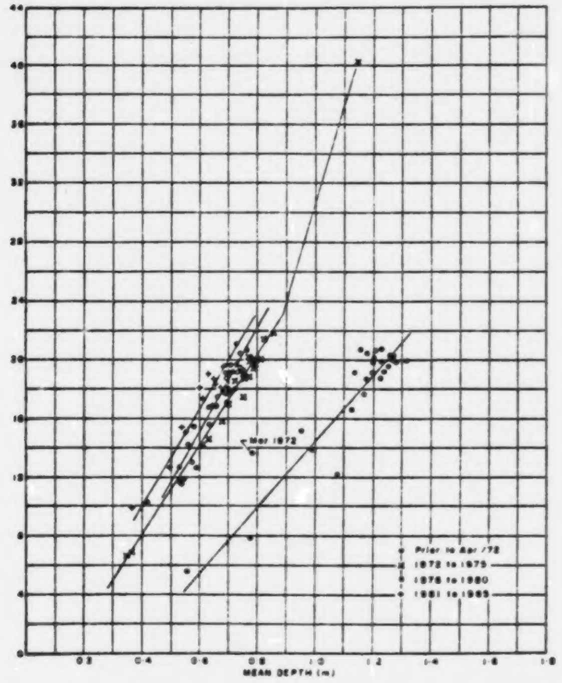


Figure B-7

Discharge Versus Mean Depth

TABLE B-2

NORTH MILK RIVER NEAR INTERNATIONAL BOUNDARY
11AA001

HYDRAULIC DATA AT CABLEWAY

Date	Discharge m^3/s	Gauge Height (m)	Mean Velocity (m/s)	Area (m^2)	Width (m)	Mean Depth (m)
1985						
July 16	19.0	1.244	1.25	15.2	24.0	0.63
June 11	18.7	1.254	1.21	15.5	24.0	0.65
May 29	19.5	1.235	1.22	16.0	23.5	0.68
Apr. 30	17.4	1.222	1.22	14.3	23.5	0.61
1984						
May 30	18.1	1.240	1.27	14.2	23.5	0.60
Mar. 26	15.4	1.144	1.23	12.5	23.0	0.54
1983						
Aug. 16	17.9	1.244	1.11	16.2	24.0	0.68
July 11	19.6	1.248	1.20	16.4	23.5	0.70
June 15	16.8	1.204	1.11	15.2	23.5	0.65
Mar. 28	15.1	1.135	1.19	12.7	23.0	0.55
Mar. 16	9.80	0.980	1.17	8.41	22.5	0.37
1982						
July 14	18.1	1.225	1.08	16.7	24.0	0.70
June 14	12.7	1.060	1.09	11.6	23.0	0.50
May 18	18.3	1.217	1.20	15.3	23.5	0.65
1981						
Aug. 25	16.9	1.194	1.11	15.2	23.0	0.66
Aug. 18	16.8	1.201	1.13	14.9	23.5	0.63
July 14	19.1	1.268	1.15	16.6	23.5	0.71
June 23	19.0	1.240	1.19	15.9	22.9	0.69
June 16	17.7	1.217	1.13	15.7	23.0	0.68
May 28	19.6	1.219	1.17	16.7	23.6	0.71
May 13	14.2	1.135	1.10	12.9	23.0	0.56
Apr. 15	12.7	1.102	1.03	12.3	23.0	0.53
Mar. 23	15.4	1.157	1.11	13.9	24.0	0.58
Mar. 12	10.1	1.012	1.05	9.66	23.0	0.42

TABLE B-2 (cont'd.)

Date	Discharge (m^3/s)	Gauge Height (m)	Mean Velocity (m/s)	Area (m^2)	Width (m)	Mean Depth (m)
1980						
Aug. 12	17.6	1.241	1.100	16.0	23.4	0.68
July 16	19.4	1.258	1.155	16.8	23.5	0.71
June 19	19.3	1.258	1.149	16.8	22.5	0.75
May 27	17.8	1.233	1.092	16.3	23.0	0.71
Apr. 9	11.7	1.082	0.944	12.4	23.0	0.54
Apr. 1	11.5	1.096	0.920	12.5	23.0	0.54
1979						
Aug. 16	17.1	1.191	1.05	16.4	23.8	0.69
July 17	18.0	1.228	1.04	17.3	24.1	0.72
June 14	19.1	1.231	1.10	17.4	23.8	0.73
May 31	11.7	1.045	0.94	12.4	23.2	0.53
1978						
Aug. 15	13.0	1.113	0.95	13.7	23.8	0.58
July 12	15.5	1.133	1.06	14.7	23.2	0.63
June 16	12.6	1.103	0.93	13.6	23.2	0.59
1977						
June 14	19.6	1.234	1.11	17.7	24.4	0.73
May 18	18.7	1.262	1.10	16.9	24.4	0.69
1976						
Sept.14	19.3	1.225	1.13	17.1	23.2	0.74
Aug. 17	20.4	1.277	1.15	17.7	23.8	0.74
July 13	20.6	1.268	1.11	18.7	24.4	0.77
June 16	21.0	1.280	1.18	17.8	24.4	0.73
May 11	17.4	1.207	1.14	15.3	23.2	0.66
1975						
Sept.17	19.1	1.295	1.09	17.5	23.2	0.75
Aug. 12	18.6	1.286	1.12	16.6	23.2	0.72
June 20	40.2	1.679	1.45	27.7	24.1	1.15
June 17	15.8	1.280	1.01	15.6	22.9	0.68
May 13	6.80	0.948	1.09	6.3	17.1	0.37

TABLE B-2 (cont'd.)

Date	Discharge m^3/s)	Gauge Height (m)	Mean Velocity (m/s)	Area (m^2)	Width (m)	Mean Depth (m)
1974						
Sept.19	17.4	1.311	1.00	17.5	23.2	0.75
Aug. 13	18.8	1.335	1.05	17.9	23.2	0.77
July 15	20.0	1.347	1.11	18.1	23.2	0.78
June 20	14.5	1.231	1.00	14.6	23.2	0.63
June 11	18.8	1.317	1.07	17.7	23.2	0.76
May 13	21.3	1.400	1.12	19.0	23.2	0.82
May 7	21.8	1.400	1.10	19.8	23.2	0.85
Apr. 17	20.0	1.338	1.12	17.9	23.2	0.77
Apr. 9	6.63	0.966	0.93	7.1	20.1	0.35
1973						
Aug. 27	14.2	1.219	1.00	14.2	23.2	0.61
Aug. 14	18.0	1.329	1.06	17.0	23.2	0.73
July 17	19.7	1.362	1.09	18.0	23.2	0.78
June 11	20.5	1.375	1.15	17.8	23.2	0.77
May 30	20.1	1.350	1.12	17.9	23.2	0.77
May 15	17.0	1.305	1.04	16.3	23.2	0.70
1972						
Sept.12	19.4	1.378	1.06	18.3	23.2	0.79
Aug. 14	20.0	1.375	1.04	19.1	23.5	0.81
July 11	19.7	1.378	1.06	18.6	23.5	0.79
"CUTOFF OCCURRED"						
Mar. 14	13.4	1.475	0.74	18.0	23.2	0.78
1971						
Sept.13	19.0	1.597	0.68	27.9	23.2	1.20
Aug. 15	19.3	1.600	0.72	26.9	23.5	1.14
July 21	20.0	1.628	0.71	28.1	23.5	1.20
Apr. 6	5.52	1.177	0.42	13.1	23.5	0.56
1970						
Sept.16	7.7	1.253	0.42	18.3	23.5	0.78
Aug. 11	18.6	1.622	0.68	27.4	23.2	1.18
July 14	20.7	1.640	0.76	27.3	23.5	1.16
June 18	16.5	1.554	0.67	24.5	23.2	1.06
Apr. 28	13.8	1.481	0.60	22.9	23.2	0.99

TABLE B-2 (cont'd.)

Date	Discharge m^3/s)	Gauge Height (m)	Mean Velocity (m/s)	Area (m^2)	Width (m)	Mean Depth (m)
1969						
Aug. 13	20.3	1.658	0.73	27.8	23.5	1.18
July 29	20.6	1.670	0.71	28.8	23.8	1.21
July 15	19.8	1.673	0.70	28.2	23.5	1.20
June 19	20.6	1.774	0.71	29.2	23.8	1.23
Apr. 1	15.1	1.646	0.68	22.0	23.2	0.95
1968						
Aug. 12	19.1	1.765	0.66	28.8	23.2	1.24
July 18	20.2	1.777	0.69	29.5	23.2	1.27
June 26	19.9	1.792	0.65	30.6	23.2	1.32
June 19	20.3	1.765	0.67	30.3	24.1	1.26
May 16	17.6	1.731	0.64	27.5	23.5	1.17
May 2	19.8	1.774	0.67	29.6	23.2	1.28
Apr. 18	20.0	1.756	0.68	29.4	23.2	1.27
1967						
Sept.12	20.2	1.795	0.69	29.5	23.2	1.27
Aug. 19	19.5	1.786	0.68	28.9	22.9	1.26
July 20	19.9	1.780	0.71	28.1	22.9	1.23
June 30	18.7	1.759	0.65	28.6	23.2	1.23
May 9	12.1	1.542	0.50	24.4	22.6	1.08

3.0 SUSPENDED SEDIMENT DATA

3.1 PERIOD OF SAMPLING AND FREQUENCY

A suspended sediment sampling program was conducted from 1974 to 1976 and during 1981 and 1982. In 1975, 1976 and 1981 sufficient samples were collected to enable the production of continuous concentration time plots, and thus the computation of daily suspended sediment discharge. In 1975 and 1976 the local land owner was hired as the observer and on average, he took samples about every third day.

Table B-3, which follows, details the number of samples taken.

TABLE B-3

NORTH MILK RIVER NEAR INTERNATIONAL BOUNDARY

NUMBER OF SUSPENDED SEDIMENT SAMPLES

YEAR	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	TOTAL
1974	-	-	2	2	1	1	2	1	9
1975	2	5	7	6	9	10	9	-	48
1976	1	2	10	9	9	10	8	3	52
1981	3	1	3	8	6	4	7	4*	36
1982	4	4	5	7	6	4	2	2*	34

*One sample taken in November.

3.2 SAMPLING LOCATION, PROCEDURES AND EQUIPMENT

In 1975 and 1976 the depth-integrated samples were collected using a DH-59 sampler suspended from a fixed boom, 10 metres in length, located 20 metres below the gauge. In the other years high flows (>10 m^3/s) were sampled at mid-stream using a DH-59 sampler from the cableway. Lower flows were sampled by wading to mid-stream using a DH-48 hand sampler. All samples were collected by depth-integrating procedures.

No depth-integrating sediment discharge measurements were made to ascertain the variation of suspended sediment concentration across the cross-section.

3.3 REPRESENTATIVITY

With only three years of sediment discharge data available and two additional years of miscellaneous suspended sediment data for the 77 years of discharge data, it would be unlikely that the sediment data would be representative of the entire flow period.

The highest flow sampled was 40.2 m^3/s, whereas the peak flow recorded during the period was 83.5 m^3/s on June 17, 1948. Thus, the

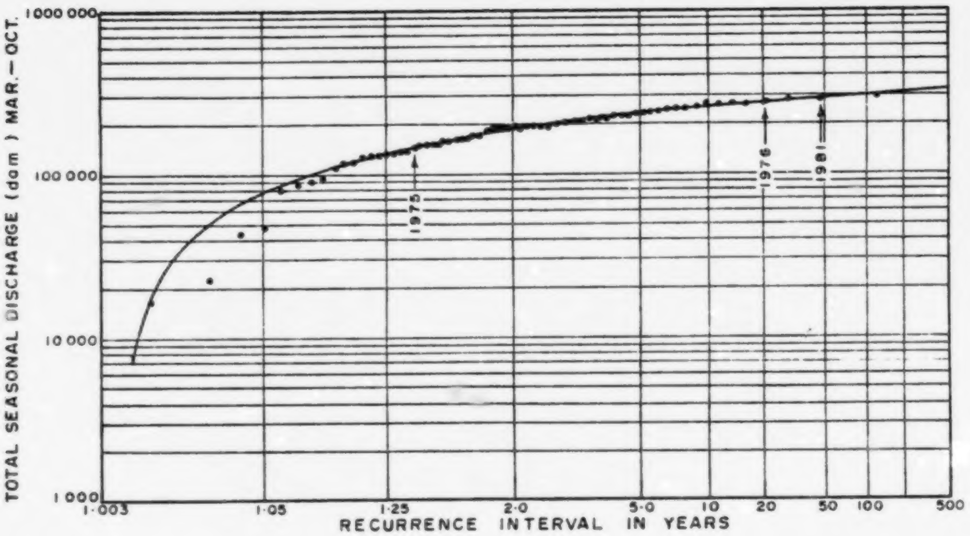


Figure B-8

Recurrence Intervals of Total Seasonal Discharge (dam^3)

range of stage has not been adequately sampled. Propitiously, two of the three years (1976 and 1981) were during the top four years of total seasonal discharge. A frequency plot of total seasonal streamflow for the period of record is contained in Figure B-8, with the three sampled years indicated by arrow.

3.4 SUSPENDED SEDIMENT DISCHARGE DATA

Three years of suspended sediment discharge data have been computed in the conventional manner. Sufficient samples had been collected in those years. The total suspended sediment discharge data for these years are contained in Table B-4 and are compared with totals computed utilizing the regression equation developed from the sampled data and shown in Figure B-9 which relates all available sampled concentrations versus discharges. Even with only 3 years of data for comparison, it quickly becomes apparent that data simulated on the basis of the regression equation can be grossly in error and can be significantly greater or less than the actual sediment load. The coefficient of correlation is only 0.29 and visual inspection shows a very large scatter about the regression line. Figure B-9 also indicates that no one regression line can adequately relate discharge to concentration, as the passage of time is a very important parameter. Apparently, the availability of sediment particles decreases with time, such that for the same flow the sediment concentrations can be much reduced later in the season. A more reasonable interpretation of relationship between concentration and discharge would be a hysteresis type loop, as sketched on Figure B-9.

Suspended sediment rating curves for individual years can be found on pages B-43 to B-47 and the instantaneous data from which these plots are derived are contained on pages B-31 to B-36.

TABLE B-4

SEASONAL SUSPENDED SEDIMENT LOAD

YEAR	SEASON	SUSPENDED SEDIMENT LOAD COMPUTED BY NORMAL PROCEDURES (TONNES)	SUSPENDED SEDIMENT LOAD SIMULATED BY REGRESSION TECHNIQUES (TONNES)	SIMULATED AS PERCENT OF COMPUTED
1975	Mar. to Oct.	18 900	7 980	42%
1976	Mar. to Oct.	17 300	16 240	94%
1981	Mar. to Oct.	12 700	16 640	131%

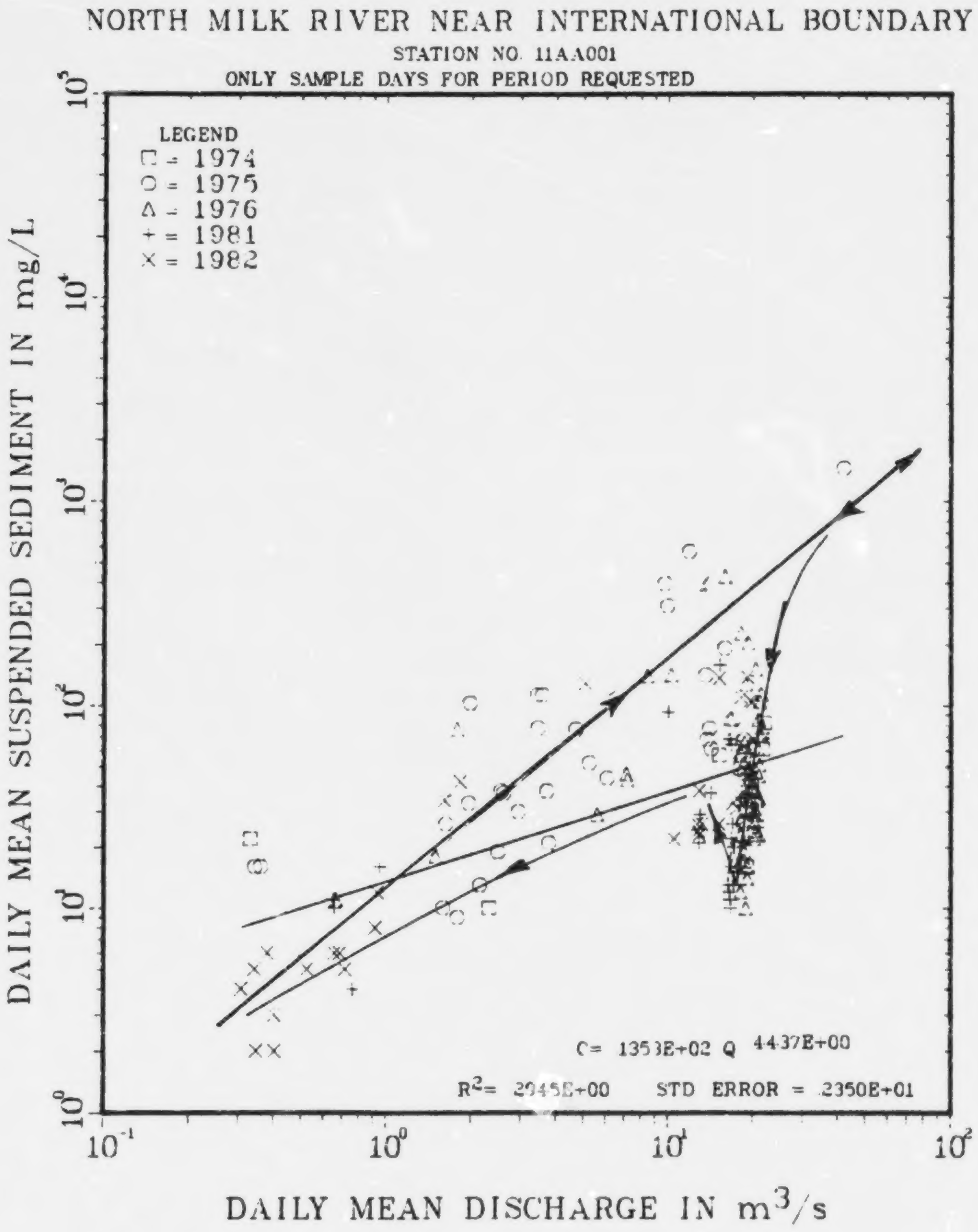


Figure B-9

Concentrations versus Discharges for all Available Sampled Data

Plots of streamflow hydrographs with sediment concentration for the sampled years can be found on pages B-28 to B-30. On page B-27 a flow duration curve for the 1909 to 1984 period can be found. On this plot the number of samples taken in each 10% flow interval are indicated in bar graph form.

4.0 SUSPENDED SEDIMENT PARTICLE SIZE DATA

No data are available.

5.0 BED MATERIAL DATA

Two bed material samples were taken on October 1, 1985. One was a surface sample taken on a side bar on the left bank about 50 metres above the gauge. This sample was taken utilizing a transect sampling procedure (Yuzyk, 1986). The second sample was a bulk subsurface sample taken below the transect line according to procedures described in Yuzyk (1986). Figure B-10 contains a plot of the data.

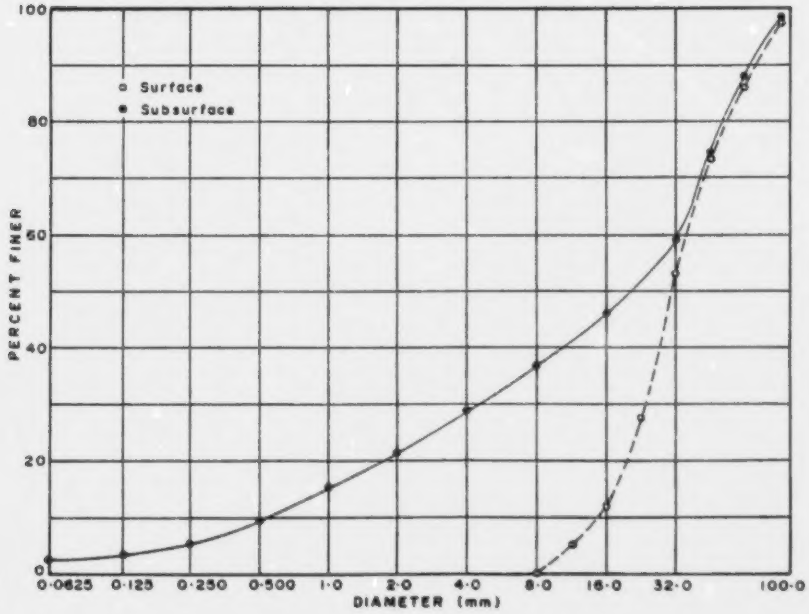


Figure B-10

Bed Material Data
North Milk River near International Boundary

6.0 BED LOAD DISCHARGE DATA

No data are available.

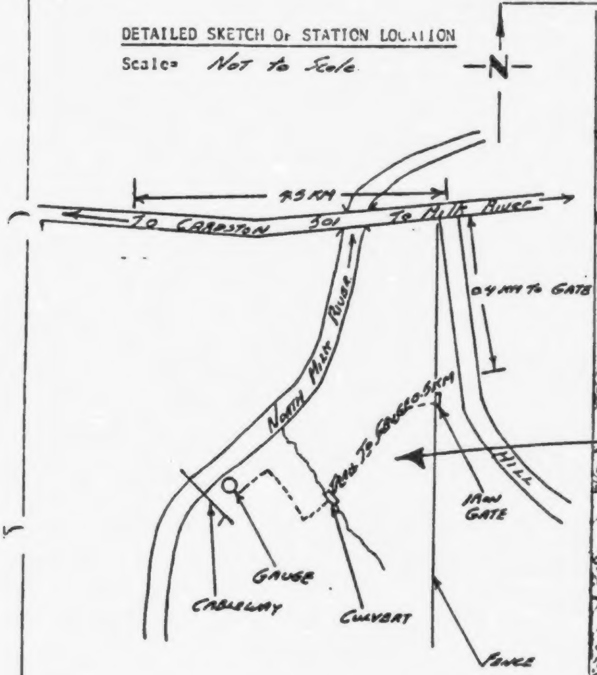
7.0 DISSOLVED SOLIDS DATA

Information on dissolved solids is available as a by-product of the laboratory analyses for either suspended sediment concentration or for particle sizes. 1981 and 1982 data are depicted in plots of discharge versus dissolved solids concentration and can be found on pages B-48 and B-49. All the available dissolved solids data are contained in the table containing instantaneous suspended sediment data, which is located on pages B-31 to B-36.

WATER SURVEY OF CANADA - CALGARY

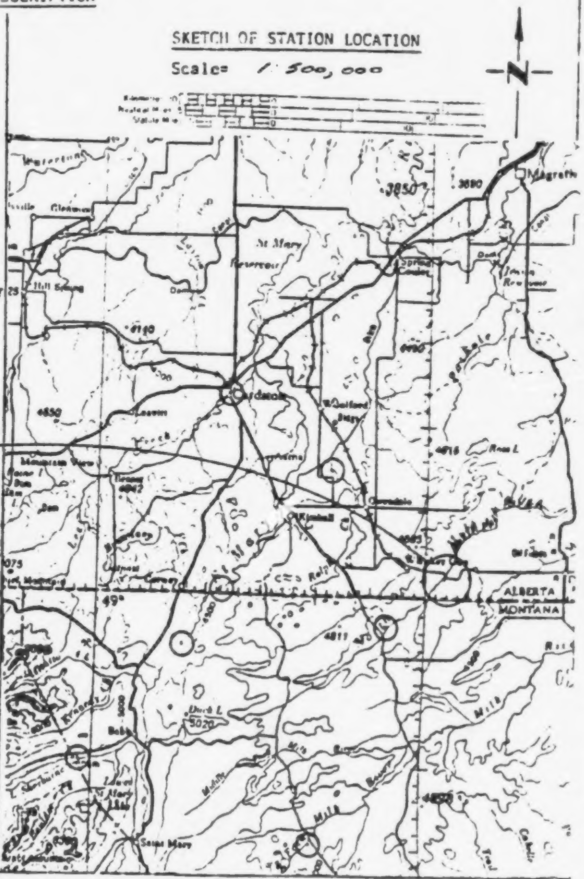
STATION DESCRIPTION

DETAILED SKETCH OF STATION LOCATION
Scale= Not to Scale


N
4.5 KM
To Cardston 301 To Milk River
0.4 KM To Gate
North Milk River
Road To Gauge 0.5 KM
Hill
Iron Gate
Gauge
Cableway
Culvert
Fence

Upper intake - 3.5 long., 0.076 diam. pipe.
Elevation: 1254.157
Lower intake - 7.0m long., 0.076 diam. pipe
Elevation: 1253.511

SKETCH OF STATION LOCATION
Scale= 1:500,000


N
Magrath
St Mary Reservoir
Cardston
Kimball
Milk River
ALBERTA
MONTANA
49°

ORIGINAL

STATION DESCRIPTION

Station No. 11AA001 Basin
Station Name North Milk River near International Boundary
Located in NE 1/4 Sec. 11 Tp. 1 Rge. 23, W4th
Latitude 49°01'19" Longitude 112°58'16"
Re Established Sept.25/62 by Water Survey of Canada

Name of Observer
Address
Rate of Pay Freq. of Obs.
(CROWN LAND)

Location of station with respect to towns, etc:
From Whiskey Gap elevators, go east on Hwy. #501 4.5 km, southeast 0.4 km, then through iron gate and follow trail west 0.5 km. Gauge is on right bank.

Description of gauge and equipment:
Recorder in round shelter.
1.5m diameter well x 3.04m
with E.C.G. 3.5m

Ght. Floor 2.44m

Measurement description:
Wading at low stages near the gauge.
High measurements are made from the cableway 30.5m above the gauge. I.P. on R.B. marked in 1m sections. Double marks at 10m intervals.

Prepared by: D.G.G. Date: October 20, 1986.

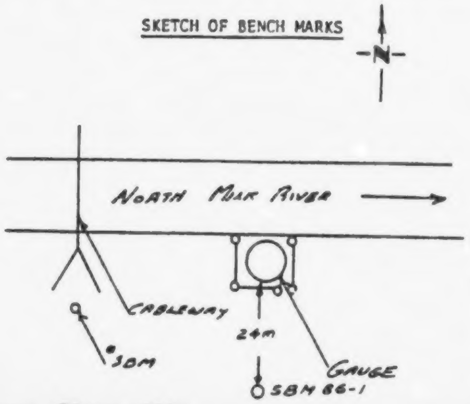
BENCH MARKS

Give elevation of bench marks, type, and number or markings, and gauge datum.

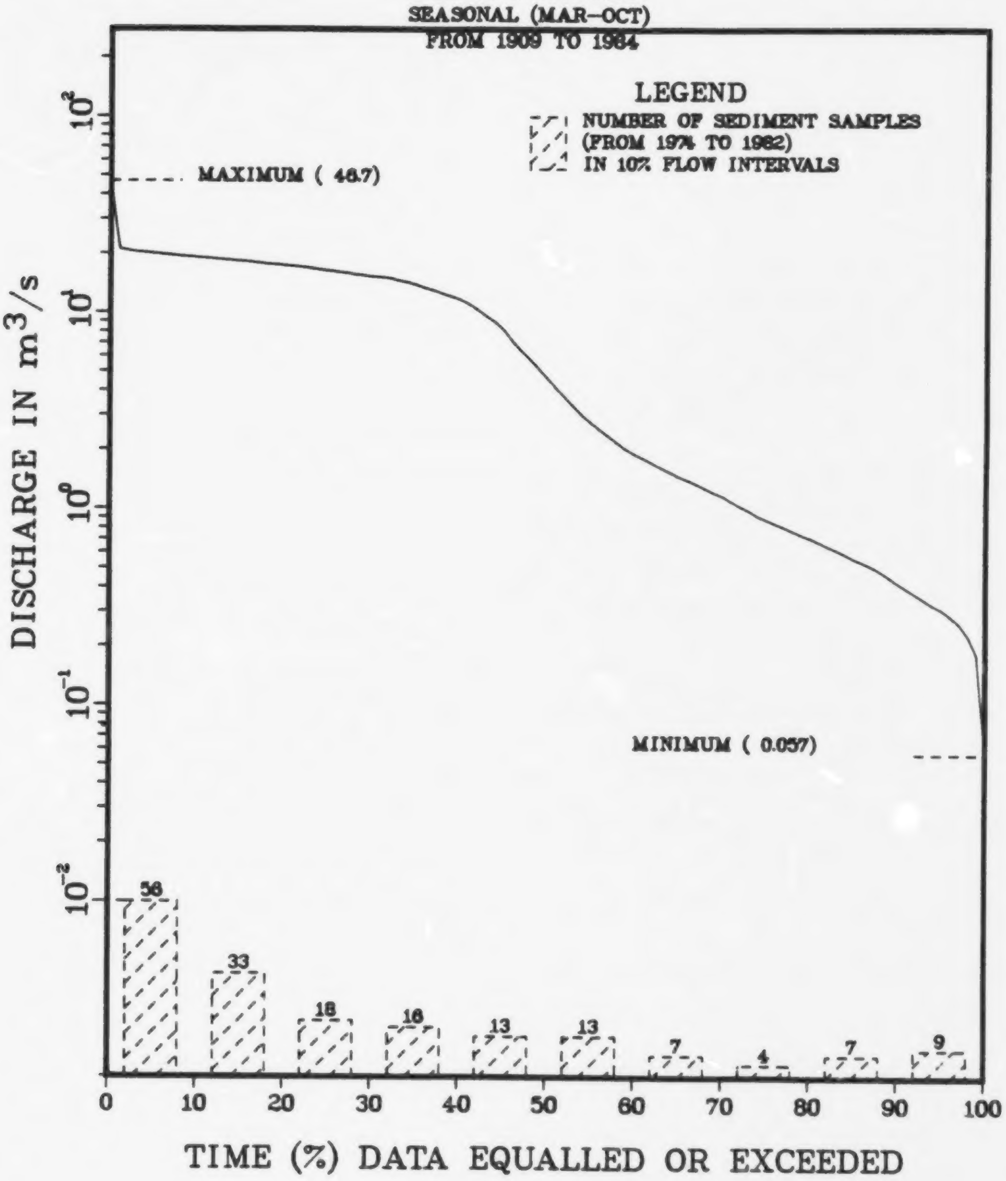
Gauge Datum= 1253.386

S.B.M. #5	- 1.2m back of right bank "A" frame. Elevation: 1257.010
TBM 84-1	- T-Bar 6.7m SE of corner fence post. Marked with boulders painted red. Elevation: 1255.906 (DESTROYED)
TBM 84-2	- SW corner of old sediment shelter (concrete base) painted red. Located 9m E of corner fence post. Elevation: 1255.886 (DESTROYED)
S.B.M. 86-1	- Located 24.0m E of shelter. Elevation: 1255.914 (Ref. to SBM #5

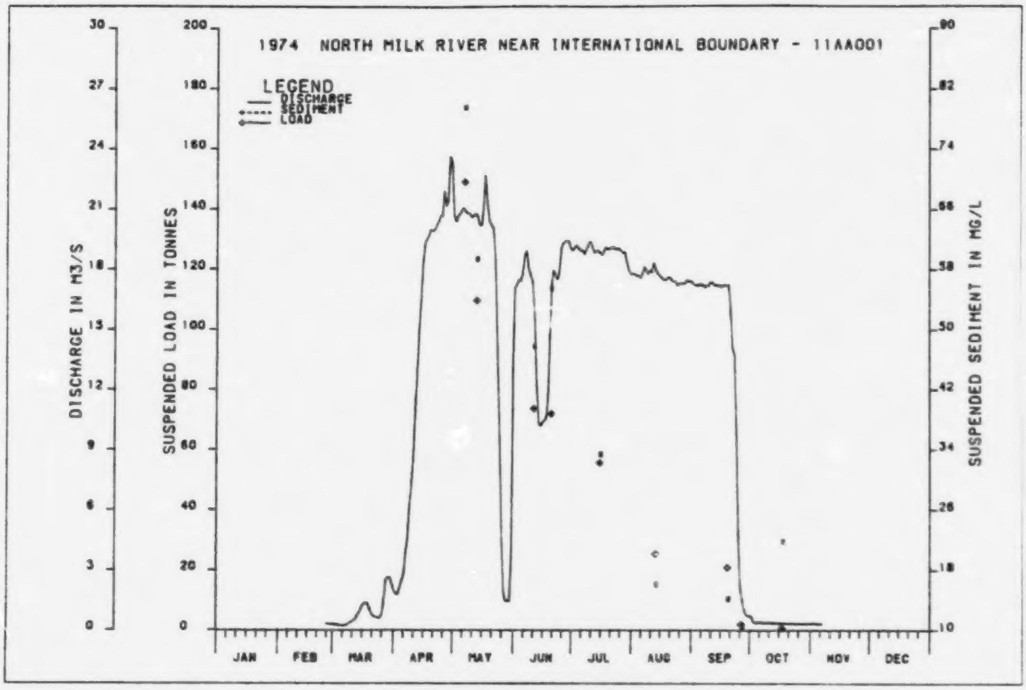
SKETCH OF BENCH MARKS

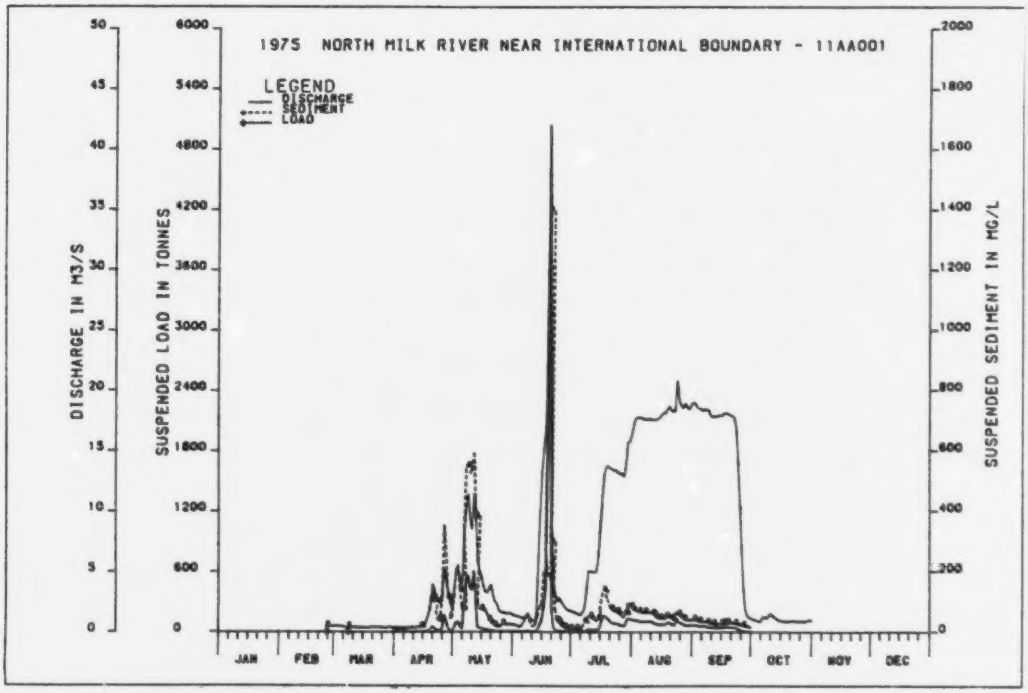

N
North Milk River
Cableway
*SBM
24m
Gauge
SBM 86-1

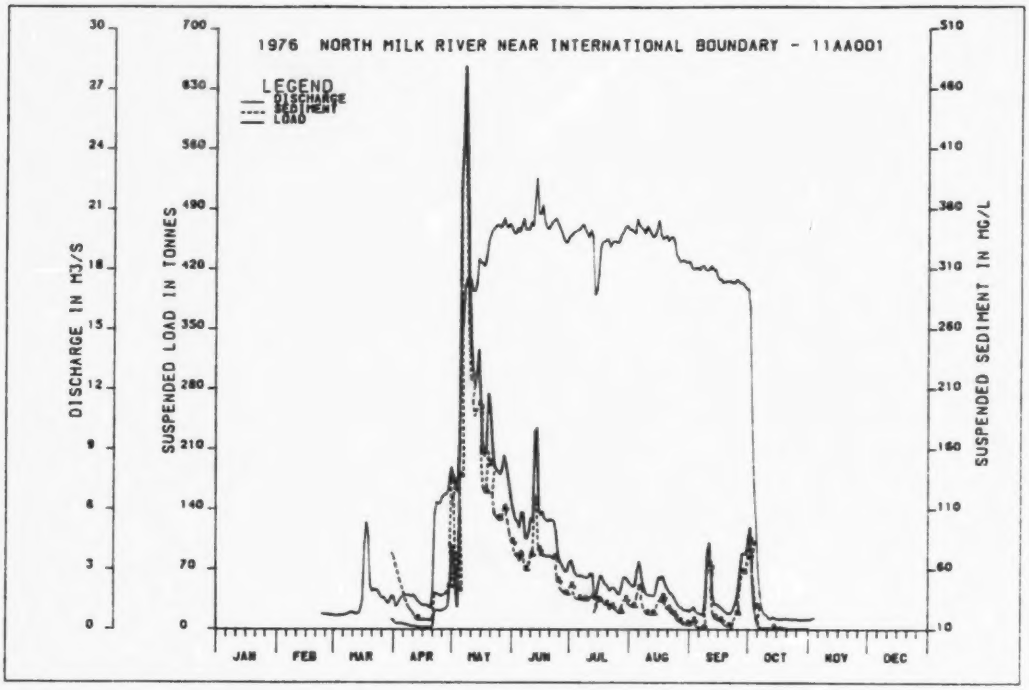
*Holding Bench Mark

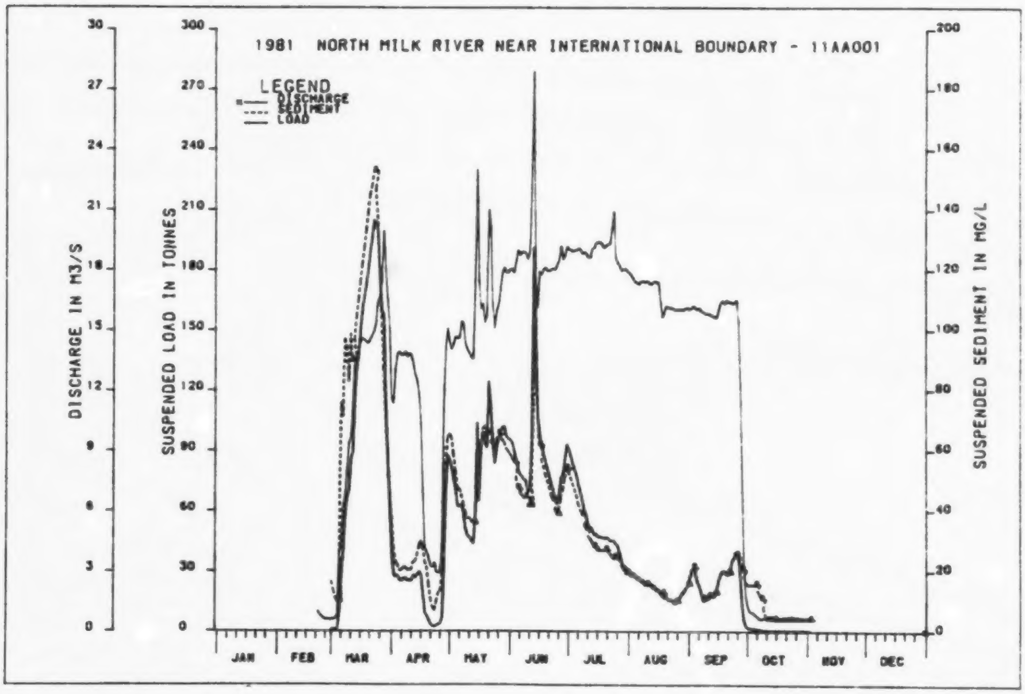


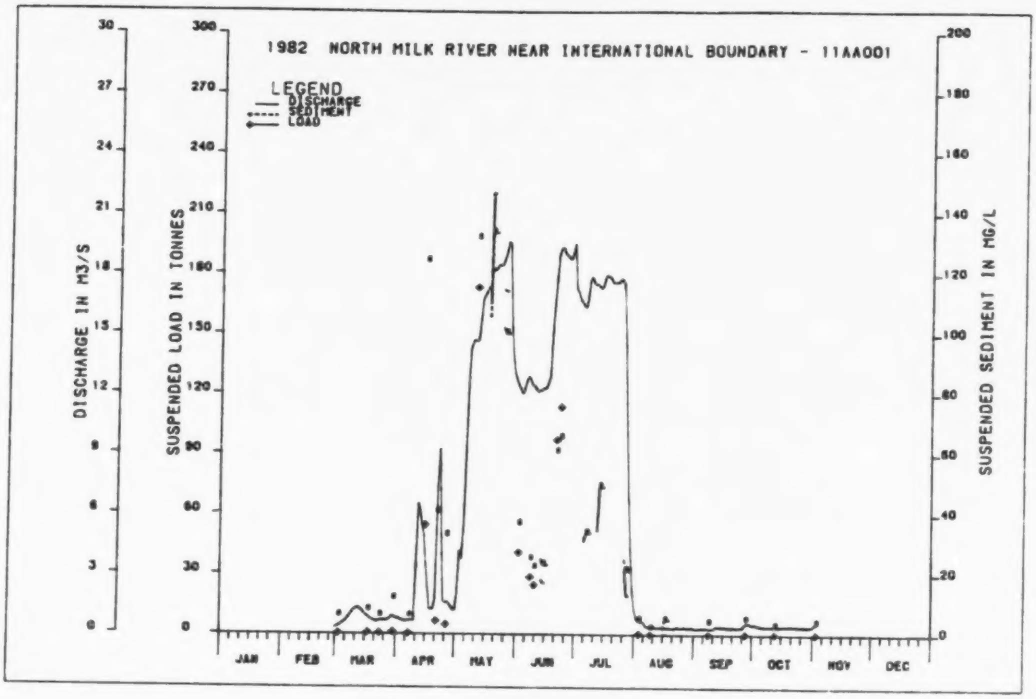
NORTH MILK RIVER NEAR INTERNATIONAL BOUNDARY
STATION NO. 11AA001
SEASONAL (MAR–OCT)
FROM 1909 TO 1984


1974 NORTH MILK RIVER NEAR INTERNATIONAL BOUNDARY - 11AA001
LEGEND
DISCHARGE
SEDIMENT
LOAD
DISCHARGE IN M3/S
0
3
6
9
12
15
18
21
24
27
30
SUSPENDED LOAD IN TONNES
0
20
40
60
80
100
120
140
160
180
200
SUSPENDED SEDIMENT IN MG/L
10
18
26
34
42
50
58
66
74
82
90
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC


1975 NORTH MILK RIVER NEAR INTERNATIONAL BOUNDARY - 11AA001
LEGEND
DISCHARGE
SEDIMENT
LOAD
DISCHARGE IN M3/S
0
5
10
15
20
25
30
35
40
45
50
SUSPENDED LOAD IN TONNES
0
600
1200
1800
2400
3000
3600
4200
4800
5400
6000
SUSPENDED SEDIMENT IN MG/L
0
200
400
600
800
1000
1200
1400
1600
1800
2000
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC


1976 NORTH MILK RIVER NEAR INTERNATIONAL BOUNDARY - 11AA001
LEGEND
DISCHARGE
SEDIMENT
LOAD
DISCHARGE IN M3/S
SUSPENDED LOAD IN TONNES
SUSPENDED SEDIMENT IN MG/L
0
3
6
9
12
15
18
21
24
27
30
0
70
140
210
280
350
420
490
560
630
700
10
60
110
160
210
260
310
360
410
460
510
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC


1981 NORTH MILK RIVER NEAR INTERNATIONAL BOUNDARY - 11AA001
LEGEND
DISCHARGE
SEDIMENT
LOAD
DISCHARGE IN M3/S
SUSPENDED LOAD IN TONNES
SUSPENDED SEDIMENT IN MG/L
0
3
6
9
12
15
18
21
24
27
30
0
30
60
90
120
150
180
210
240
270
300
0
20
40
60
80
100
120
140
160
180
200
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC


1982 NORTH MILK RIVER NEAR INTERNATIONAL BOUNDARY - 11AA001
LEGEND
DISCHARGE
SEDIMENT
LOAD
DISCHARGE IN M3/S
0
3
6
9
12
15
18
21
24
27
30
SUSPENDED LOAD IN TONNES
0
30
60
90
120
150
180
210
240
270
300
SUSPENDED SEDIMENT IN MG/L
0
20
40
60
80
100
120
140
160
180
200
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC

NORTH MILK RIVER NEAR INTERNATIONAL BOUNDARY

MONTH	DAY	TIME	DISSOLVED SOLIDS (mg/L)	INSTANTANEOUS CONCENTRATION (mg/L)	DISCHARGE (m^3/s)
		INSTANTANEOUS DATA FOR 1974			
MAY	7	1345	105	74 M	21.8
MAY	7	1350		76 M	21.8
MAY	7	1355		89 M	21.8
MAY	7	1400		91 M	21.8
MAY	7	1405		93 M	21.8
MAY	7	1415		71 M	21.8
MAY	13	0810	93	61	21.3
JUN	11	1400	99	49	18.8
JUN	20	0920	74	57	14.5
JUL	15	1620	76	34	20.0
AUG	13	1220	67	16	18.8
SEP	19	1420	64	14	17.4
SEP	26	1215	88	10	2.22
OCT	17	1330	216	22	0.328
		INSTANTANEOUS DATA FOR 1975			
FEB	25	1645	192	19	0.433
MAR	8	1135	232	16	0.343
APR	15	1325	244	16	0.365
APR	20	1125	175	98	1.97
APR	22	1220	173	108	3.54
APR	24	1120	165	38	2.57
APR	29	1330	164	97	3.45
MAY	6	0900	200	65	3.40
MAY	9	0945	174	971	12.3
MAY	13	1010	135	448	8.83
MAY	13	1525		249	6.80
MAY	16	0745	184	76	5.07
MAY	20	1245	210	32	2.79
MAY	23	1430	232	17	2.55
MAY	27	0945	214	26	1.67
MAY	27	1225		214	1.67
JUN	17	0905	110	191	15.3
JUN	17	1510		220	15.8
JUN	17	1540		185	15.8
JUN	20	1600	140	1194	40.2
JUN	20	1610		1182	40.2
JUN	20	1910		959	27.8

MONTH	DAY	TIME	DISSOLVED SOLIDS (mg/L)	INSTANTANEOUS CONCENTRATION (mg/L)	DISCHARGE (m^3/s)
INSTANTANEOUS DATA FOR 1975 (cont'd.)					
JUN	21	0830	173	296	10.3
JUN	21	1630		207	8.13
JUN	21	1640		205	8.13
JUN	24	0950	264	33	2.65
JUN	25	1100	262	30	3.14
JUN	28	0930	267	13	2.27
JUL	1	1045	288	9	1.83
JUL	4	0920	250	10	1.59
JUL	8	1345	278	33	1.80
JUL	11	1545	141	51	5.27
JUL	15	1000	135	40	5.97
JUL	15	1140		79	5.97
JUL	18	0900	106	144	13.0
JUL	22	1020	98	77	14.0
JUL	25	1700	99	67	13.8
JUL	29	0930	98	56	14.0
AUG	1	0850	104	86	16.8
AUG	5	0930	92	3	18.4
AUG	8	0925	97	66	18.4
AUG	12	1240	89	69	18.6
AUG	12	1305		55	18.6
AUG	13	1220	96	54	18.3
AUG	16	1630	95	46	18.4
AUG	19	0805	94	50	18.7
AUG	22	0840	89	46	18.7
AUG	25	1645	88	57	19.7
AUG	28	1015	89	41	19.4
SEP	2	1700	89	41	19.3
SEP	5	1305	91	34	18.3
SEP	9	0840	88	31	19.1
SEP	12	1020	85	26	18.4
SEP	16	1900	84	28	18.7
SEP	17	1050	82	31	19.1
SEP	17	1100		30	19.1
SEP	19	1115	94	30	18.7
SEP	23	1445	87	28	17.6
SEP	27	0840	119	21	4.28
OCT	15	1735	232	24	0.983
OCT	30	1130	283	6	1.01
INSTANTANEOUS DATA FOR 1976					
MAR	31	1105		76	1.85

MONTH	DAY	TIME	DISSOLVED SOLIDS (mg/L)	INSTANTANEOUS CONCENTRATION (mg/L)	DISCHARGE (m^3/s)
INSTANTANEOUS DATA FOR 1976 (cont'd.)					
APR	13	1155		18	1.53
APR	29	1020		39	6.82
APR	29	1025		40	6.82
MAY	1	0900	184	142	8.75
MAY	4	0820	150	41	7.11
MAY	5	1000	150	62	8.27
MAY	7	1955	133	440	16.4
MAY	11	0830	116	231	18.4
MAY	11	1700		226	17.4
MAY	11	1720		227	17.4
MAY	15	1100	116	210	19.5
MAY	18	1915	111	127	19.2
MAY	21	0745	104	161	20.5
MAY	25	1045	101	108	21.0
MAY	28	0940	96	117	21.7
JUN	1	0825		85	10.8
JUN	4	0930		72	21.0
JUN	8	2000		63	20.7
JUN	11	0905		74	21.2
JUN	15	1220		74	21.5
JUN	16	1010		73	21.0
JUN	16	1030	113	70	21.0
JUN	23	2035	94	71	21.4
JUN	25	0845	93	52	21.0
JUN	29	1030	99	40	20.2
JUL	2	1000	97	48	20.5
JUL	6	0845	92	36	20.8
JUL	9	0915	91	35	20.7
JUL	13	1635	95	35	20.6
JUL	13	1720		43	20.6
JUL	13	2120		25	19.2
JUL	16	1525	89	35	18.5
JUL	20	0950	88	31	20.1
JUL	23	1845	91	29	20.1
JUL	27	0850	87	24	20.1
JUL	30	1230	82	36	21.0
AUG	3	1600	85	29	20.5
AUG	6	1815	90	44	20.8
AUG	10	1000	87	23	20.8
AUG	13	1935	92	23	20.4
AUG	17	1500	106	36	20.4
AUG	17	1520		31	20.4
AUG	18	0800	104	39	20.1

MONTH	DAY	TIME	DISSOLVED SOLIDS (mg/L)	INSTANTANEOUS CONCENTRATION (mg/L)	DISCHARGE (m^3/s)
INSTANTANEOUS DATA FOR 1976 (cont'd.)					
AUG	21	1640	93	27	20.2
AUG	24	0825	85	23	20.1
AUG	27	0930	78	16	18.9
AUG	31	0835	88	14	19.2
SEP	3	1320	88	18	18.7
SEP	8	1930	88	10	18.8
SEP	11	0820	90	69	18.7
SEP	14	1250	86	21	19.3
SEP	14	1315		18	19.3
SEP	17	0845	84	17	18.2
SEP	21	1050	81	12	18.2
SEP	25	0930	82	21	18.0
SEP	28	0955	79	59	17.9
OCT	2	1430	87	88	16.5
OCT	5	1030	88	28	5.89
OCT	14	0930	243	11	0.739
INSTANTANEOUS DATA FOR 1981					
MAR	4	1300	237	8	0.647
MAR	12	1110	73	165 M	10.1
MAR	12			162 M	10.1
MAR	12			153	10.1
MAR	12			156 M	10.1
MAR	12			155 M	10.1
MAR	12			163 M	10.1
MAR	23	1430	102	87 M	15.4
MAR	23			86 M	15.4
MAR	23			87	15.4
MAR	23			92 M	15.4
MAR	23			96 M	15.4
MAR	23			98 M	15.4
APR	15	1018	119	29	12.7
MAY	13	1310	121	32 M	14.2
MAY	13			33 M	14.2
MAY	13			32	14.2
MAY	13			36 M	14.2
MAY	13			41 M	14.2
MAY	13			37 M	14.2
MAY	21	1400	139	58	16.5
MAY	26	1330	109	69	16.9
JUN	3	1110	98	59	19.0
JUN	5	0945	99	49	19.0

MONTH	DAY	TIME	DISSOLVED SOLIDS (mg/L)	INSTANTANEOUS CONCENTRATION (mg/L)	DISCHARGE (m^3/s)
INSTANTANEOUS DATA FOR 1981 (cont'd.)					
JUN	9	1115	102	46	19.7
JUN	11	0940	105	42	19.4
JUN	16	1700	120	61	17.7
JUN	23	1420	108	45	19.0
JUN	25	1230	109	39	18.7
JUN	30	1030	101	57	19.5
JUL	8	1315		40	19.4
JUL	10	1105		35	19.6
JUL	14	1405		29	20.1
JUL	20	0950		29	19.9
JUL	24	1050		25	20.4
JUL	29	1040		21	18.6
AUG	10	1215	89	16	18.2
AUG	18	1605	85	13	16.8
AUG	25	1800	86	11	16.9
AUG	31	1110	82	16	16.9
SEP	3	0000	85	23	16.8
SEP	8	1135	85	11	16.7
SEP	14	1355	94	13	16.2
SEP	21	1015	94	20	17.1
SEP	24	1055	94	26	17.0
SEP	28	1030	100	21	12.9
OCT	5	1105	220	16	0.963
OCT	8	0910	260	12	0.664
OCT	15	1540	268	4	0.776
NOV	2	1300	271	4	0.684
INSTANTANEOUS DATA FOR 1982					
MAR	3	1605	287	6	0.431
MAR	17	1205	277	8	0.916
MAR	23	0945	284	6	0.657
MAR	30	0910	286	12	0.931
APR	7	1210	287	6	0.685
APR	15	0955	149	129	5.08
APR	21	0830	281	43	1.41
APR	21	0830		40	1.41
APR	26	1605	258	34	1.50
MAY	11	1705	135	137	15.2
MAY	18	1635	115	110	18.3
MAY	19	1240	135	139	19.3
MAY	25	1630	131	106	19.7
MAY	26	1830	126	104	20.2

MONTH	DAY	TIME	DISSOLVED SOLIDS (mg/L)	INSTANTANEOUS CONCENTRATION (mg/L)	DISCHARGE (m^3/s)
		INSTANTANEOUS DATA FOR 1982 (cont'd.)			
JUN	2	1300	137	38	12.9
JUN	8	1000	132	26	13.2
JUN	10	1030	108	23	12.9
JUN	14	1715	101	26	12.7
JUN	15	1540	102	24	12.7
JUN	21	1130	99	63	18.4
JUN	23	1135	89	68	20.1
JUL	6	1845	80	33	16.9
JUL	7	0720	86	35	17.2
JUL	13	0645	80	36	18.2
JUL	14	1155	118	51	18.1
JUL	27	1120	111	26	15.6
JUL	28	1330	101	22	10.3
AUG	3	1110	174	5	0.723
AUG	9	1050	203	2	0.407
AUG	16	1435	217	2	0.350
AUG	17	1150	219	5	0.336
SEP	8	0900	235	4	0.321
SEP	27	1340	237	5	0.565
OCT	12	1325	251	3	0.395
NOV	2	1340	269	4	0.561

M - MEASUREMENT

WATER SURVEY OF CANADA
JAN 19 1983 PAGE 528
CALGARY, ALTA.

NORTH MILK RIVER NEAR INTERNATIONAL BOUNDARY

STATION NO. 11AA001

SUSPENDED SEDIMENT FOR 1979

	JAN				FEB				MAR				
DAY	TEMP. (CEL)	DAILY DISCHARGE (M3/S)	MEAN CON-CENTRATION (MG/L)	DAILY LOAD (TNE)	TEMP. (CEL)	DAILY DISCHARGE (M3/S)	MEAN CON-CENTRATION (MG/L)	DAILY LOAD (TNE)	TEMP. (CEL)	DAILY DISCHARGE (M3/S)	MEAN CON-CENTRATION (MG/L)	DAILY LOAD (TNE)	DAY
1										0.487 B			1
2										0.507 B			2
3										0.507 B			3
4										0.487 B			4
5										0.436 B			5
6										0.391 B			6
7										0.374 B			7
8									1.0	0.343 B	16 S	0.47	8
9										0.360 B			9
10										0.374 B			10
11										0.391 B			11
12										0.374 B			12
13										0.360 B			13
14										0.343 B			14
15										0.343 B			15
16										0.343 B			16
17										0.328 B			17
18										0.328 B			18
19										0.343 B			19
20										0.374 B			20
21										0.391 B			21
22										0.391 B			22
23										0.374 B			23
24										0.374 B			24
25					1.0	0.436 B	19 S	0.72		0.374 B			25
26						0.453 B				0.360 B			26
27						0.467 B				0.343 B			27
28						0.487 B				0.343 B			28
29										0.360 B			29
30										0.391 B			30
31										0.343 B			31
TOTAL										11.817			TOTAL
MEAN										0.381			MEAN

WATER SURVEY OF CANADA
JAN 19 1983 PAGE 529
CALGARY, ALTA.

NORTH MILK RIVER NEAR INTERNATIONAL BOUNDARY

STATION NO. 11AA001

SUSPENDED SEDIMENT FOR 1979

	APR				MAY				JUN				
DAY	TEMP. (CEL)	DAILY DISCHARGE (M3/S)	MEAN CON-CENTRATION (MG/L)	DAILY LOAD (TNE)	TEMP. (CEL)	DAILY DISCHARGE (M3/S)	MEAN CON-CENTRATION (MG/L)	DAILY LOAD (TNE)	TEMP. (CEL)	DAILY DISCHARGE (M3/S)	MEAN CON-CENTRATION (MG/L)	DAILY LOAD (TNE)	DAY
1		0.328 B	10	0.28		2.24	49	9.48		1.44	24	2.99	1
2		0.360 B	10	0.31		3.62	123	38.5		1.34	22	2.55	2
3		0.360 B	11	0.34		5.10	213	93.9		1.36	23	2.70	3
4		0.343 B	11	0.33		5.32	231	106		1.27	17	1.87	4
5		0.328 B	12	0.34		4.56	147	57.9		1.24	16	1.71	5
6		0.311 B	12	0.32		3.45	77 S	23.0		1.15	23	2.29	6
7		0.328 B	13	0.37		8.52	362	266		1.23	35	3.72	7
8		0.343 B	13	0.39		10.3	572	509		1.33	47	5.40	8
9		0.360 B	14	0.44		11.9	568 S	584		1.50	64	8.29	9
10		0.360 B	14	0.44		9.71	546	458		1.09	37	3.48	10
11		0.374 B	15	0.48		8.83	559	426		0.985	20	1.70	11
12		0.391 B	15	0.51		11.9	614	631		0.934	19	1.53	12
13		0.405 B	15	0.52	10.0	9.77	395 S	333		0.934	26	2.10	13
14		0.391 B	16	0.54		5.97	99	51.1		4.45	55	21.1	14
15	1.0	0.360 B	16 S	0.50		5.13	79	35.0		9.71	86	72.1	15
16		0.391 B	22	0.74		4.70	76 S	30.9		13.7	98	116	16
17		0.547 B	23	1.09		3.88	73	24.5	11.0	15.9	192 S	264	17
18		0.988 B	37	3.16		3.40	72	21.2		17.9	280	433	18
19		1.47 B	56	7.11		3.34	64	18.5		30.9	784	2 090	19
20	1.0	1.98 B	103 S	17.6		3.71	38 S	12.2	10.0	41.9	1 450 S	5 250	20
21		4.13 B	150	53.5		4.02	30	10.4	14.0	10.0	307 S	265	21
22	1.0	3.57 B	113 S	34.9		3.06	26	6.87		4.53	130	50.9	22
23		2.79 B	70	16.9		2.49	19 S	4.09		3.17	77	21.1	23
24	1.0	2.55 B	38 S	8.37		2.43	16	3.36	16.0	2.61	37 S	8.34	24
25		2.47 B	36	7.68		1.81	20	3.13	10.0	2.94	30 S	7.62	25
26		3.14 B	116	31.5		1.64	20	2.83		2.60	23	5.17	26
27		5.55 B	366	176	10.0	1.63	26 S	3.66		2.34	18	3.64	27
28		4.39 B	271	103		1.61	26	3.62	9.0	2.19	13 S	2.41	28
29	2.0	3.43	113 S	33.5		1.53	23	3.04		1.90	11	1.81	29
30		2.35	47	9.54		1.58	24	3.28		1.83	10	1.58	30
31						1.60	26	3.59					31
TOTAL		45.054		516.70		148.75		3 777.03		184.333		8 654.10	TOTAL
MEAN		1.50		17.2		4.80		122		6.14		288	MEAN

WATER SURVEY OF CANADA
JAN 19 1983 PAGE 530
CALGARY, ALTA.

NORTH MILK RIVER NEAR INTERNATIONAL BOUNDARY

STATION NO. 11AA001

SUSPENDED SEDIMENT FOR 1975

DAY	JUL TEMP. (CEL)	JUL DAILY DISCHARGE (M3/S)	JUL MEAN CONCENTRATION (MG/L)	JUL DAILY LOAD (TNE)	AUG TEMP. (CEL)	AUG DAILY DISCHARGE (M3/S)	AUG MEAN CONCENTRATION (MG/L)	AUG DAILY LOAD (TNE)	SEP TEMP. (CEL)	SEP DAILY DISCHARGE (M3/S)	SEP MEAN CONCENTRATION (MG/L)	SEP DAILY LOAD (TNE)	DAY
1	16.0	1.79	9 S	1.39	14.0	17.0	85 S	125		19.8	41	70.1	1
2		1.73	9	1.35		17.9	78	121	14.0	19.8	41 S	70.1	2
3		1.67	9	1.30		18.5	76	121		19.4	40	67.0	3
4	19.0	1.59	10 S	1.37		18.5	73	117		19.3	37	61.7	4
5		1.48	10	1.28	17.0	18.5	68 S	109	15.0	19.2	34 S	56.4	5
6		1.43	9	1.11		18.5	67	107		19.1	33	54.5	6
7		1.70	18	2.64		18.3	67	106		19.2	35	58.1	7
8	19.0	1.96	33 S	5.59	15.0	18.4	66 S	105		19.2	35	58.1	8
9		3.51	40	12.1		18.3	68	108	14.0	19.1	31 S	51.2	9
10		5.24	54	24.4		18.4	70	111		18.7	29	46.9	10
11	25.0	5.24	52 S	23.5		18.3	67	106		18.5	27	43.2	11
12		5.15	47	20.9	17.0	18.3	62 S	98.0	13.0	18.6	26 S	41.8	12
13		5.15	43	19.1	15.0	18.3	54 S	85.4		18.6	25	40.2	13
14		5.18	39	17.5		18.4	49	77.9		18.7	24	38.8	14
15	21.0	6.06	44 S	23.0		18.5	47	75.1		18.7	25	40.4	15
16		8.38	77	55.8	16.0	18.7	46 S	74.3	14.0	18.7	27 S	43.6	16
17		11.2	126	122		18.9	45	73.5	12.0	18.9	30 S	49.0	17
18	19.0	13.6	142 S	167		18.9	45	73.5		18.9	33	53.9	18
19		14.3	126	156	14.0	19.2	52 S	86.3	12.0	18.8	31 S	50.4	19
20		14.3	110	136		19.5	59	99.4		18.7	30	48.5	20
21		14.1	93	113		19.1	54	89.1		18.6	30	48.2	21
22	17.0	14.0	77 S	93.1	15.0	19.0	44 S	72.2		18.5	29	46.4	22
23		13.9	72	86.5		19.1	41	67.7	15.0	17.6	28 S	42.6	23
24		13.9	71	85.3		21.7	69	129		14.6	26	32.8	24
25	21.0	13.7	68 S	80.5	15.0	19.9	60 S	103		10.7	25	23.1	25
26		13.6	62	72.9		19.5	55	92.7		7.19	23	14.3	26
27		13.6	57	67.0		19.3	51	85.0	9.0	3.77	21 S	6.84	27
28		13.4	50	57.9	16.0	19.7	42 S	71.5		1.96	20	3.39	28
29	19.0	14.2	61 S	74.8		19.4	40	67.0		1.38	18	2.15	29
30		16.4	96	136		19.2	41	68.0		1.23	16	1.70	30
31		16.5	96	136		19.5	41	69.1					31
TOTAL		267.86		1 795.33		584.7		2 893.7		473.43		1 265.38	TOTAL
MEAN		8.64		57.9		18.9		93.3		15.8		42.2	MEAN

WATER SURVEY OF CANADA
JAN 19 1983 PAGE 531
CALGARY, ALTA.

NORTH MILK RIVER NEAR INTERNATIONAL BOUNDARY

STATION NO. 11AA001

SUSPENDED SEDIMENT FOR 1975

DAY	OCT TEMP. (CEL)	OCT DAILY DISCHARGE (M3/S)	OCT MEAN CONCENTRATION (MG/L)	OCT DAILY LOAD (TNE)	NOV TEMP. (CEL)	NOV DAILY DISCHARGE (M3/S)	NOV MEAN CONCENTRATION (MG/L)	NOV DAILY LOAD (TNE)	DEC TEMP. (CEL)	DEC DAILY DISCHARGE (M3/S)	DEC MEAN CONCENTRATION (MG/L)	DEC DAILY LOAD (TNE)	DAY
1		1.14											1
2		1.08											2
3		1.00											3
4		0.985											4
5		0.963											5
6		0.900											6
7		1.30											7
8		1.26											8
9		1.22											9
10		1.35											10
11		1.41											11
12		1.40											12
13		1.25											13
14		1.11											14
15		1.01											15
16		0.949											16
17		0.923											17
18		0.900											18
19		0.969											19
20		0.903											20
21		0.905											21
22		0.934											22
23		0.971											23
24		0.889 B											24
25		0.872 B											25
26		0.925 B											26
27		0.889 B											27
28		0.852 B											28
29		0.879 B											29
30		1.01 A											30
31		1.01 E											31
TOTAL		32.199											TOTAL
MEAN		1.04											MEAN

SUMMARY FOR THE MONTHS MAR TO OCT

SUSPENDED SEDIMENT CONCENTRATION(MG/L)	SUSPENDED SEDIMENT LOAD(TNE/D)
MAXIMUM DAILY 1 450 ON JUN 26	MAXIMUM DAILY 5 290 ON JUN 20

TYPE OF GAUGE - RECORDING
LOCATION - LAT 49 01 19 N
LONG 112 58 18 W
DRAINAGE AREA 238 KM2
REGULATED FLOW SINCE 1916
INTERNATIONAL GAUGING STATION

A - MANUAL GAUGE B - ICE CONDITIONS E - ESTIMATED S - SAMPLE(S) COLLECTED THIS DAY
SEDIMENT DATA PARTIALLY CONTRIBUTED BY UNITED STATES GEOLOGICAL SURVEY

WATER SURVEY OF CANADA
JAN 19 1983 PAGE 532
CALGARY, ALTA.

NORTH MILK RIVER NEAR INTERNATIONAL BOUNDARY

STATION NO. 11AA001

SUSPENDED SEDIMENT FOR 1976

	JAN				FEB				MAR				
DAY	TEMP. (CEL)	DAILY DISCHARGE (M3/S)	MEAN CON-CENTRATION (MG/L)	DAILY LOAD (TNE)	TEMP. (CEL)	DAILY DISCHARGE (M3/S)	MEAN CON-CENTRATION (MG/L)	DAILY LOAD (TNE)	TEMP. (CEL)	DAILY DISCHARGE (M3/S)	MEAN CON-CENTRATION (MG/L)	DAILY LOAD (TNE)	DAY
1										0.719 B			1
2										0.697 B			2
3										0.697 B			3
4										0.719 B			4
5										0.719 B			5
6										0.742 B			6
7										0.765 B			7
8										0.790 B			8
9										0.841 B			9
10										0.917 B			10
11										0.867 B			11
12										0.816 B			12
13										0.790 B			13
14										0.841 B			14
15										1.10 B			15
16										1.36 B			16
17										4.28 B			17
18										5.61			18
19										4.81			19
20										2.27			20
21										1.97			21
22										2.10			22
23										2.03			23
24						0.790 B				2.03			24
25						0.790 B				1.77			25
26						0.765 B				1.63			26
27						0.765 B				1.66			27
28						0.742 B				1.48			28
29						0.742 B				1.34			29
30										1.49			30
31									1.0	1.79	76 S	11.8	31
TOTAL										49.810			TOTAL
MEAN										1.61			MEAN

WATER SURVEY OF CANADA
JAN 19 1983 PAGE 533
CALGARY, ALTA.

NORTH MILK RIVER NEAR INTERNATIONAL BOUNDARY

STATION NO. 11AA001

SUSPENDED SEDIMENT FOR 1976

	APR				MAY				JUN				
DAY	TEMP. (CEL)	DAILY DISCHARGE (M3/S)	MEAN CON-CENTRATION (MG/L)	DAILY LOAD (TNE)	TEMP. (CEL)	DAILY DISCHARGE (M3/S)	MEAN CON-CENTRATION (MG/L)	DAILY LOAD (TNE)	TEMP. (CEL)	DAILY DISCHARGE (M3/S)	MEAN CON-CENTRATION (MG/L)	DAILY LOAD (TNE)	DAY
1		1.68	73	10.6	8.0	8.47	140 S	102	10.0	20.9	85 S	153	1
2		1.18	66	6.73		7.70	124	82.5		20.6	80	142	2
3		1.31	60	6.79		7.42	72	46.2		20.6	75	133	3
4		1.53	53	7.01	9.0	7.16	43 S	26.6	10.0	20.9	72 S	130	4
5		1.69	47	6.86	8.0	10.3	142 S	126		20.7	69	123	5
6		1.74	42	6.31		14.8	391	500		21.0	78	142	6
7		1.77	36	5.51	14.0	16.0	427 S	590		21.4	76	141	7
8		1.80	31	4.82		17.8	445	684	19.0	20.8	63 S	113	8
9		1.76	28	4.26		18.3	380	601		20.8	61	110	9
10		1.70	26	3.82		18.3	277	438		20.8	66	119	10
11		1.79	24	3.71	9.0	18.2	226 S	355	16.0	21.2	74 S	136	11
12		1.67	20	2.89		17.6	207	315		21.0	73	132	12
13	9.0	1.50	18 S	2.33		17.6	194	295		22.1	126	241	13
14		1.40	18	2.18		18.0	199	309		23.5	120	244	14
15		1.30	18	2.02	9.0	19.3	204 S	340	14.0	21.6	78 S	146	15
16		1.25	18	1.94		19.1	164	271	10.0	21.6	74 S	138	16
17		1.25	18	1.94		19.0	133	218		22.1	75	143	17
18		1.25	18	1.94	13.0	18.9	128 S	209		21.2	73	134	18
19		1.16	18	1.80		19.4	133	223	12.0	20.9	73	132	19
20		1.09	17	1.60		20.2	164	286		20.8	73	131	20
21		2.07	20	3.58	8.0	20.5	152 S	269		21.0	74	134	21
22		5.95	41	21.1		20.8	126	226		21.2	72	132	22
23		6.63	41	23.5		20.9	110	199	12.0	21.3	71 S	131	23
24		6.54	40	22.6		21.0	107	194		21.4	64	118	24
25		6.57	39	22.1	10.0	21.1	105 S	191	10.0	21.1	51 S	93.0	25
26		6.91	39	23.3		20.9	104	188		20.9	46	83.1	26
27		6.99	40	24.2		21.0	107	194		20.6	44	78.3	27
28		7.05	41	25.0	10.0	21.4	114 S	211		20.3	42	73.7	28
29	4.0	7.11	46 S	28.3		21.0	111	201	17.0	20.1	40 S	69.5	29
30		8.01	83	57.4		20.9	103	186		20.2	41	71.6	30
31						21.1	93	170					31
TOTAL		93.65		336.14		544.15		8 246.3		632.6		3 864.2	TOTAL
MEAN		3.12		11.2		17.6		266		21.1		129	MEAN

WATER SURVEY OF CANADA
JAN 19 1983 PAGE 534
CALGARY, ALTA.

NORTH MILK RIVER NEAR INTERNATIONAL BOUNDARY

STATION NO. 11AA001

SUSPENDED SEDIMENT FOR 1976

DAY	JUL				AUG				SEP				DAY
	TEMP. (CEL)	DAILY DISCHARGE (M3/S)	MEAN CON-CENTRATION (MG/L)	DAILY LOAD (TNE)	TEMP. (CEL)	DAILY DISCHARGE (M3/S)	MEAN CON-CENTRATION (MG/L)	DAILY LOAD (TNE)	TEMP. (CEL)	DAILY DISCHARGE (M3/S)	MEAN CON-CENTRATION (MG/L)	DAILY LOAD (TNE)	
1		20.5	46	81.5		20.8	31	55.7		19.1	13	21.5	1
2	18.0	20.5	47 S	83.2		20.8	30	53.9		18.8	15	24.4	2
3		20.7	42	75.1	22.0	20.7	29 S	51.9	17.0	18.7	17 S	27.5	3
4		20.7	38	68.0		20.6	30	53.4		18.8	14	22.7	4
5		20.8	36	64.7		21.4	39	72.1		18.8	12	19.5	5
6	17.0	20.8	36 S	64.7	23.0	21.0	45 S	81.6		18.7	12	19.4	6
7		21.0	36	65.3		20.9	38	68.6		18.9	11	18.0	7
8		21.1	35	63.8		20.8	30	53.9	13.0	18.9	10 S	16.3	8
9	18.0	20.8	35 S	62.9		20.6	26	46.3		18.7	21	33.9	9
10		20.6	35	62.3	14.0	21.0	23 S	41.7		18.7	59	95.3	10
11		20.4	36	63.5		20.8	23	41.3	11.0	18.7	65 S	105	11
12		20.8	38	68.3		20.6	23	40.9		18.9	44	71.9	12
13	17.0	20.4	38 S	67.0	24.0	20.4	23 S	40.5		18.7	24	38.8	13
14		17.4	24	36.1		20.5	23	40.7	13.0	18.7	19 S	30.7	14
15		17.6	28	42.6		20.8	29	52.1		18.4	19	30.2	15
16	24.0	18.4	34 S	54.1		21.3	35	64.4		18.2	18	28.3	16
17		19.9	38	65.3	19.0	20.6	34 S	60.5	13.0	18.2	17 S	26.7	17
18		20.2	36	62.8	12.3	20.3	37 S	64.9		18.0	16	24.9	18
19		20.2	32	55.8		20.4	33	58.2		18.1	14	21.9	19
20	19.0	20.3	31 S	54.4		20.5	29	51.4		18.1	13	20.3	20
21		20.3	29	50.9	19.0	20.2	27 S	47.1	14.0	18.1	12 S	18.8	21
22		19.9	27	46.4		20.4	25	44.1		18.1	12	18.8	22
23	18.0	20.2	29 S	50.6		20.4	24	42.3		18.0	14	21.8	23
24		20.2	29	50.6	15.0	20.2	22 S	38.4		18.0	18	28.0	24
25		20.2	27	47.1		19.5	20	33.7	12.0	18.2	23 S	36.2	25
26		20.1	25	43.4		19.3	18	30.0		18.1	32	50.0	26
27	16.0	20.3	24 S	42.1	12.0	19.1	16 S	26.4		18.0	48	74.6	27
28		20.6	29	51.6		19.2	16	26.5	12.0	18.0	59 S	91.8	28
29		20.7	35	62.6		19.2	14	23.2		17.9	60	92.8	29
30	16.0	21.0	35 S	63.5		19.1	14	23.1		17.7	60	91.8	30
31		21.0	33	59.9	16.0	19.1	14 S	23.1					31
TOTAL		627.6		1 830.1		630.5		1 491.9		552.2		1 221.8	TOTAL
MEAN		20.2		59.0		20.3		48.1		18.4		40.7	MEAN

WATER SURVEY OF CANADA
JAN 19 1983 PAGE 535
CALGARY, ALTA.

NORTH MILK RIVER NEAR INTERNATIONAL BOUNDARY

STATION NO. 11AA001

SUSPENDED SEDIMENT FOR 1976

DAY	OCT				NOV				DEC				DAY
	TEMP. (CEL)	DAILY DISCHARGE (M3/S)	MEAN CON-CENTRATION (MG/L)	DAILY LOAD (TNE)	TEMP. (CEL)	DAILY DISCHARGE (M3/S)	MEAN CON-CENTRATION (MG/L)	DAILY LOAD (TNE)	TEMP. (CEL)	DAILY DISCHARGE (M3/S)	MEAN CON-CENTRATION (MG/L)	DAILY LOAD (TNE)	
1		17.7	72	110		0.507							1
2	14.0	16.7	86 S	124		0.513							2
3		11.2	66	63.9		0.505 A							3
4		7.56	44	28.7									4
5	9.0	5.61	29 S	14.1									5
6		3.31	17	4.86									6
7		1.98	12	2.05									7
8		1.15	11	1.09									8
9		0.847	11	0.80									9
10		0.793	11	0.75									10
11		0.694	11	0.66									11
12		0.547	11	0.52									12
13		0.541	11	0.51									13
14	6.0	0.665	11 S	0.63									14
15		0.566	11	0.54									15
16		0.547	12	0.57									16
17		0.532 B	11	0.51									17
18		0.532 B	12	0.55									18
19		0.532 B	11	0.51									19
20		0.575	11	0.55									20
21		0.542	11	0.52									21
22		0.549	10	0.47									22
23		0.498 B	10	0.43									23
24		0.515 B	10	0.44									24
25		0.552	10	0.48									25
26		0.530	10	0.46									26
27		0.498	10	0.43									27
28		0.499	10	0.43									28
29		0.501	10	0.43									29
30		0.513	10	0.44									30
31		0.515	10	0.44									31
TOTAL		78.160		366.77									TOTAL
MEAN		2.52		11.8									MEAN

SUMMARY FOR THE MONTHS MAR TO OCT

SUSPENDED SEDIMENT CONCENTRATION(MG/L)			SUSPENDED SEDIMENT LOAD(TNE/D)		
MAXIMUM DAILY	445	ON MAY 08	MAXIMUM DAILY	884	ON MAY 08

TYPE OF GAUGE - RECORDING
LOCATION - LAT 49 01 19 N
LONG 112 30 18 W
DRAINAGE AREA 230 KM2
REGULATED FLOW SINCE 1916
INTERNATIONAL GAUGING STATION

A - MANUAL GAUGE B - ICE CONDITIONS S - SAMPLE(S) COLLECTED THIS DAY
SEDIMENT DATA PARTIALLY CONTRIBUTED BY UNITED STATES GEOLOGICAL SURVEY

WATER SURVEY OF CANADA
JAN 19 1983 PAGE 536
CALGARY, ALTA.

NORTH MILK RIVER NEAR INTERNATIONAL BOUNDARY

STATION NO. 11AA001

SUSPENDED SEDIMENT FOR 1981

	JAN				FEB				MAR				
DAY	TEMP. (CEL)	DAILY DISCHARGE (M3/S)	MEAN CON-CENTRATION (MG/L)	DAILY LOAD (TNE)	TEMP. (CEL)	DAILY DISCHARGE (M3/S)	MEAN CON-CENTRATION (MG/L)	DAILY LOAD (TNE)	TEMP. (CEL)	DAILY DISCHARGE (M3/S)	MEAN CON-CENTRATION (MG/L)	DAILY LOAD (TNE)	DAY
1										0.591 B	17	0.87	1
2										0.591 B	14	0.71	2
3										0.604 B	11	0.57	3
4									1.0	0.657 B	10 S	0.57	4
5										0.774 B	27	1.81	5
6										4.13 B	79	28.2	6
7										4.38 B	74	28.0	7
8										6.42 B	101	56.0	8
9										6.90 B	98	58.4	9
10										8.21 B	86	61.0	10
11										9.78 B	103	87.0	11
12									3.0	10.0	93 S	80.4	12
13										11.6	101	101	13
14										13.7	109	129	14
15										14.3	115	142	15
16										14.4	121	151	16
17										15.0	127	165	17
18										15.2	133	175	18
19										15.1	139	181	19
20										15.0	145	188	20
21										14.9	151	194	21
22										15.1	154	201	22
23						1.00 A			5.5	15.3	159 S	210	23
24						0.838				15.5	153	205	24
25						0.713				15.9	141	194	25
26						0.644 B				17.1	123	182	26
27						0.598 B				17.3	106	158	27
28						0.591 B				18.1	91	142	28
29										20.8	74	133	29
30										18.8	61	99.1	30
31										17.2	49	72.8	31
TOTAL										353.337		3 426.43	TOTAL
MEAN										11.4		111	MEAN

WATER SURVEY OF CANADA
JAN 19 1983 PAGE 537
CALGARY, ALTA.

NORTH MILK RIVER NEAR INTERNATIONAL BOUNDARY

STATION NO. 11AA001

SUSPENDED SEDIMENT FOR 1981

	APR				MAY				JUN				
DAY	TEMP. (CEL)	DAILY DISCHARGE (M3/S)	MEAN CON-CENTRATION (MG/L)	DAILY LOAD (TNE)	TEMP. (CEL)	DAILY DISCHARGE (M3/S)	MEAN CON-CENTRATION (MG/L)	DAILY LOAD (TNE)	TEMP. (CEL)	DAILY DISCHARGE (M3/S)	MEAN CON-CENTRATION (MG/L)	DAILY LOAD (TNE)	DAY
1		15.7	39	52.9		15.7	68	92.2		18.6	61	98.0	1
2		12.0	29	30.1		15.0	67	86.8		17.9	63	97.5	2
3		11.8	24	24.5		14.6	61	76.9	13.0	18.8	58 S	94.2	3
4		13.5	23	26.8		14.9	55	70.8		18.6	53	85.2	4
5		14.4	21	26.1		15.3	49	64.8	12.0	19.2	49 S	81.3	5
6		14.5	21	26.3		15.2	49	64.4		19.8	48	82.1	6
7		14.3	22	27.2		15.2	47	61.7		19.5	47	79.2	7
8		14.3	22	27.2		16.1	44	61.2		19.7	46	78.3	8
9		14.5	21	26.3		15.9	41	56.3	13.0	19.7	46 S	78.3	9
10		14.2	21	25.8		14.9	39	50.2		19.6	43	72.8	10
11		14.4	21	26.1		14.6	39	49.2	12.0	19.3	43 S	71.7	11
12		14.3	24	29.7		14.4	38	47.3		19.7	50	85.1	12
13		13.9	24	28.8	10.0	14.2	37 S	45.4		23.0	79 E	157	13
14		13.3	26	29.9		14.1	39	47.5		29.1	105 E	264	14
15	5.9	13.0	29 S	32.6		17.9	52	80.4		18.0	77 E	120	15
16		12.3	31	32.9		24.0	45	93.3	12.0	16.8	64 S	92.9	16
17		10.8	29	27.1		18.2	65	102		18.7	59	95.3	17
18		7.27	24	15.1		16.7	70	101		18.5	57	91.1	18
19		4.32	22	8.21		17.0	71	104		18.8	54	87.7	19
20		4.08	16	5.64		16.0	67	92.6		18.9	52	84.9	20
21		3.82	11	3.63	10.0	16.4	68 S	96.4		18.7	53	85.6	21
22		3.35	8	2.32		21.9	65	123		18.7	47	75.9	22
23		3.30	7	2.00		20.9	67	121	13.0	18.8	45 S	73.1	23
24		3.52	10	3.04		17.0	64	94.0		18.8	42	68.2	24
25		3.04	13	3.41		15.7	66	89.5	16.0	18.8	40 S	65.0	25
26		2.99	14	3.62	13.0	16.6	68 S	97.5		19.0	42	68.9	26
27		3.08	19	5.06		16.9	67	97.8		19.3	46	76.7	27
28		4.34	36	13.5		17.7	66	101		20.0	49	84.7	28
29		11.6	58	58.1		18.6	65	104		19.3	53	88.4	29
30		14.7	67	85.1		18.9	63	103	16.0	19.5	56 S	94.3	30
31						18.6	62	99.6					31
TOTAL		300.61		709.03		519.1		2 574.8		584.6		2 772.6	TOTAL
MEAN		10.0		23.6		16.7		83.1		19.5		92.4	MEAN

WATER SURVEY OF CANADA
JAN 19 1983 PAGE 538
CALGARY, ALTA.

NORTH MILK RIVER NEAR INTERNATIONAL BOUNDARY

STATION NO. 11AA001

SUSPENDED SEDIMENT FOR 1981

	JUL				AUG				SEP				
DAY	TEMP. (CEL)	DAILY DISCHARGE (M3/S)	MEAN CON-CENTRATION (MG/L)	DAILY LOAD (TNE)	TEMP. (CEL)	DAILY DISCHARGE (M3/S)	MEAN CON-CENTRATION (MG/L)	DAILY LOAD (TNE)	TEMP. (CEL)	DAILY DISCHARGE (M3/S)	MEAN CON-CENTRATION (MG/L)	DAILY LOAD (TNE)	DAY
1		20.0	55	95.0		18.7	20	32.3		16.8	18	26.1	1
2		19.8	53	90.7		18.6	19	30.5		16.7	21	30.3	2
3		19.8	51	87.2		18.5	19	30.4		16.8	22 S	31.9	3
4		19.7	49	83.4		18.3	19	30.0		16.7	21	30.7	4
5		19.8	47	80.4		18.1	18	28.1		16.8	18	26.1	5
6		19.8	44	75.3		18.1	18	28.1		16.7	16	23.1	6
7		19.9	42	72.2		18.0	17	26.4		16.8	14	20.3	7
8	14.0	19.8	40 S	68.4		18.2	17	26.7	17.0	16.6	11 S	15.9	8
9		19.6	37	62.7		18.2	16	25.2		16.6	11	15.8	9
10	16.0	19.7	35 S	59.6	20.0	18.1	16 S	25.0		16.5	12	17.1	10
11		19.6	33	55.9		18.2	16	25.2	17.0	16.5	12 S	17.1	11
12		19.4	32	53.6		18.1	16	25.0		16.5	13	18.5	12
13		19.4	31	52.0		18.0	15	23.3		16.4	13	18.4	13
14	15.0	19.9	29 S	49.9		18.1	15	23.5	15.5	16.4	13 S	18.4	14
15		19.9	27	46.4		18.2	14	22.0		16.3	15	21.1	15
16		20.2	28	48.9		18.1	14	21.9		16.3	18	25.3	16
17		20.7	28	49.9		18.1	13	20.3		16.7	20	28.9	17
18		20.2	28	48.9	20.5	17.1	13 S	19.2		17.1	21	31.0	18
19		20.1	28	48.6		16.3	12	16.9		17.2	21	31.2	19
20	19.0	19.9	28 S	48.1		16.6	12	17.2		17.0	20	29.4	20
21		20.0	28	48.4		16.9	11	16.1	11.0	17.2	20 S	29.7	21
22		20.1	27	46.9		16.8	11	16.0		17.1	22	32.5	22
23		20.1	26	45.2		16.8	11	16.0		17.1	25	36.9	23
24	16.0	20.8	25 S	44.9		16.8	10	14.5	10.0	17.0	26 S	38.2	24
25		21.8	27	50.9	23.0	16.7	10 S	14.4		17.1	27	39.9	25
26		19.4	27	45.3		16.7	11	15.9		17.2	28	41.6	26
27		19.1	25	41.3		16.7	12	17.3		16.1	26	36.2	27
28		19.0	23	37.8		16.7	13	18.8	10.0	12.9	21 S	23.4	28
29	19.0	19.7	21 S	35.7		16.7	14	20.2		7.30	19	12.3	29
30		18.8	20	32.5		16.7	15	21.6		3.48	17	5.11	30
31		18.8	20	32.5	17.0	16.8	16 S	23.2					31
TOTAL		613.3		1 739.2		541.9		691.2		476.28		772.31	TOTAL
MEAN		19.8		56.1		17.5		22.3		15.9		25.7	MEAN

WATER SURVEY OF CANADA
JAN 19 1983 PAGE 539
CALGARY, ALTA.

NORTH MILK RIVER NEAR INTERNATIONAL BOUNDARY

STATION NO. 11AA001

SUSPENDED SEDIMENT FOR 1981

	OCT				NOV				DEC				
DAY	TEMP. (CEL)	DAILY DISCHARGE (M3/S)	MEAN CON-CENTRATION (MG/L)	DAILY LOAD (TNE)	TEMP. (CEL)	DAILY DISCHARGE (M3/S)	MEAN CON-CENTRATION (MG/L)	DAILY LOAD (TNE)	TEMP. (CEL)	DAILY DISCHARGE (M3/S)	MEAN CON-CENTRATION (MG/L)	DAILY LOAD (TNE)	DAY
1		1.85	16	2.56		0.670	4	0.23					1
2		1.26	16	1.74	5.0	0.683 A	4 S	0.24					2
3		1.02	16	1.41									3
4		0.976	16	1.35									4
5	6.0	0.951	16 S	1.31									5
6		0.827	14	1.00									6
7		0.754	13	0.85									7
8	7.0	0.649	11 S	0.62									8
9		0.636	8	0.44									9
10		0.643	6	0.33									10
11		0.718	4	0.25									11
12		0.760	4	0.26									12
13		0.787	4	0.27									13
14		0.787	4	0.27									14
15	7.5	0.760	4 S	0.26									15
16		0.703	4	0.24									16
17		0.665	4	0.23									17
18		0.666	4	0.23									18
19		0.657	4	0.23									19
20		0.715	4	0.25									20
21		0.710	4	0.25									21
22		0.700	4	0.24									22
23		0.725	4	0.25									23
24		0.763	4	0.26									24
25		0.756	4	0.26									25
26		0.697	4	0.24									26
27		0.697	4	0.24									27
28		0.695	4	0.24									28
29		0.673	4	0.23									29
30		0.690	4	0.24									30
31		0.685	4	0.23									31
TOTAL		24.524		16.78									TOTAL
MEAN		0.791		0.54									MEAN

SUMMARY FOR THE MONTHS MAR TO OCT

SUSPENDED SEDIMENT CONCENTRATION(MG/L)		SUSPENDED SEDIMENT LOAD(TNE/D)	
MAXIMUM DAILY	193 ON MAR 23	MAXIMUM DAILY	264 ON JUN 14

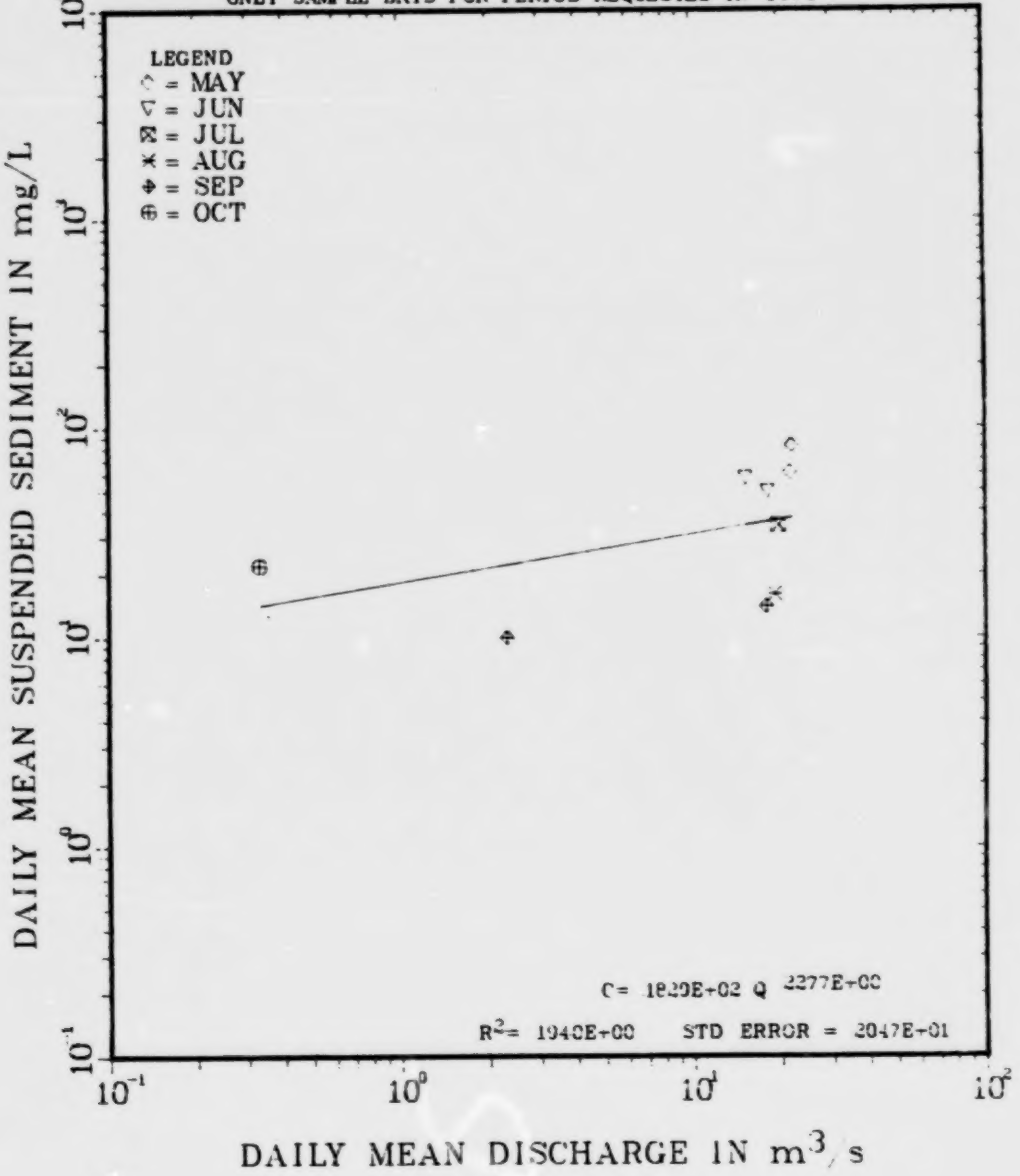
TYPE OF GAUGE - RECORDING
LOCATION - LAT 49 01 19 N
LONG 112 50 16 W
DRAINAGE AREA 230 KM2
REGULATED FLOW SINCE 1916
INTERNATIONAL GAUGING STATION

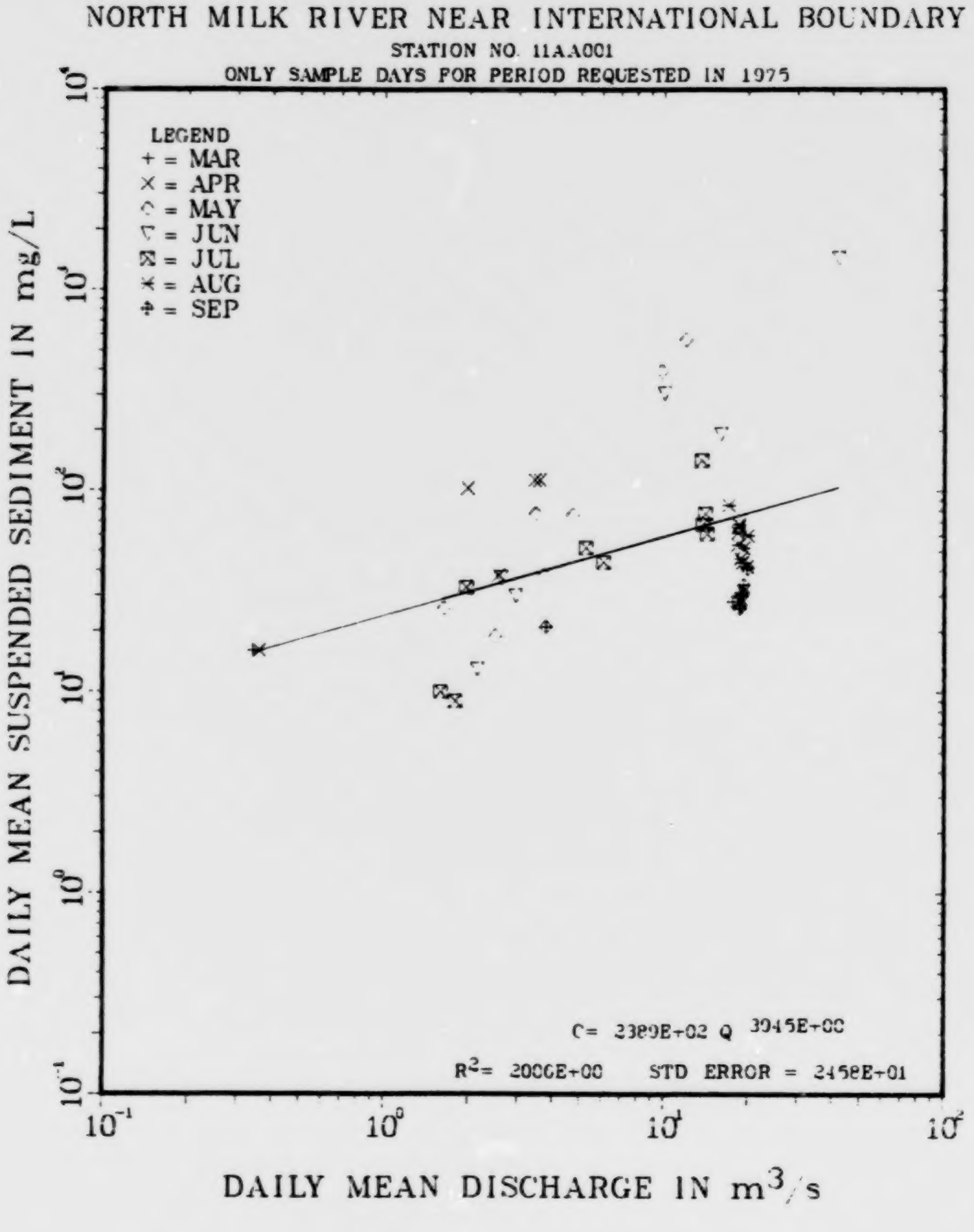
A - MANUAL GAUGE B - ICE CONDITIONS E - ESTIMATED S - SAMPLE(S) COLLECTED THIS DAY
SEDIMENT DATA PARTIALLY CONTRIBUTED BY UNITED STATES GEOLOGICAL SURVEY

NORTH MILK RIVER NEAR INTERNATIONAL BOUNDARY

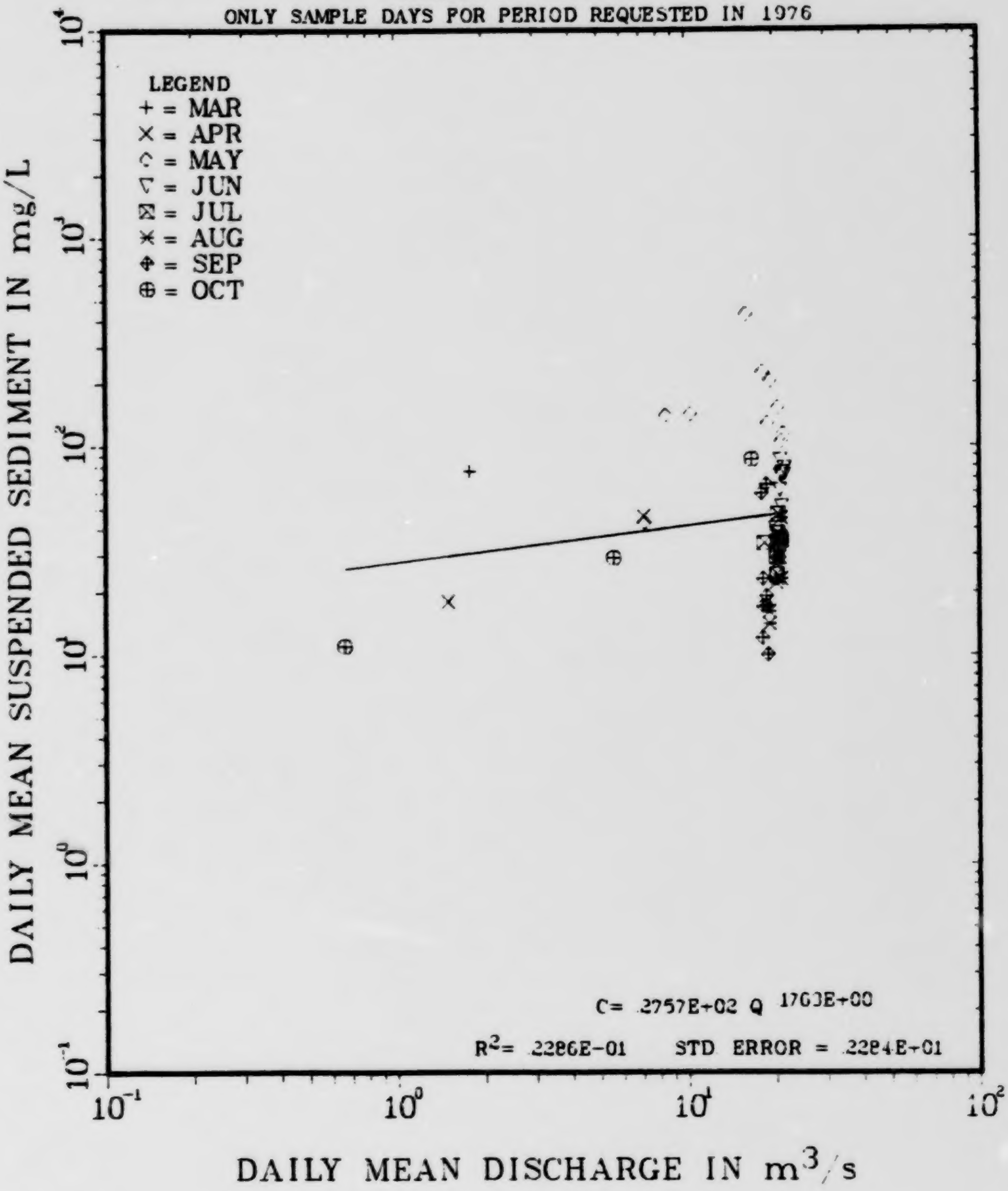
STATION NO. 11AA001

ONLY SAMPLE DAYS FOR PERIOD REQUESTED IN 1974

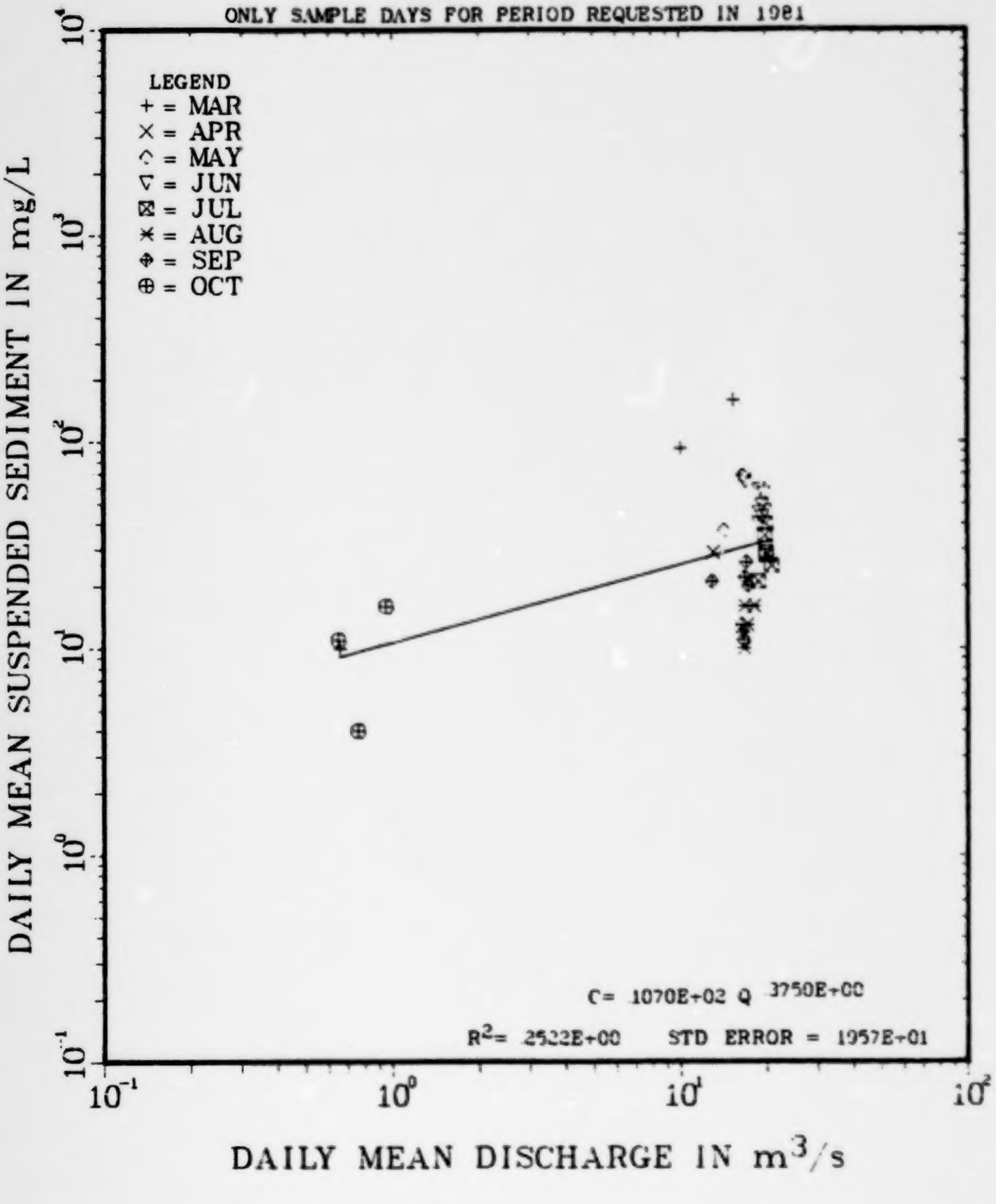



NORTH MILK RIVER NEAR INTERNATIONAL BOUNDARY
STATION NO. 11AA001
ONLY SAMPLE DAYS FOR PERIOD REQUESTED IN 1975
LEGEND
+ = MAR
× = APR
◇ = MAY
▽ = JUN
☒ = JUL
✳ = AUG
✜ = SEP
C= 2389E+02 Q 3045E+00
R² = 2000E+00
STD ERROR = 2458E+01
10⁻¹
10⁰
10¹
10²
10³
10⁴
DAILY MEAN SUSPENDED SEDIMENT IN mg/L
10⁻¹
10⁰
10¹
10²
DAILY MEAN DISCHARGE IN m³/s

NORTH MILK RIVER NEAR INTERNATIONAL BOUNDARY
STATION NO. 11AA001
ONLY SAMPLE DAYS FOR PERIOD REQUESTED IN 1976



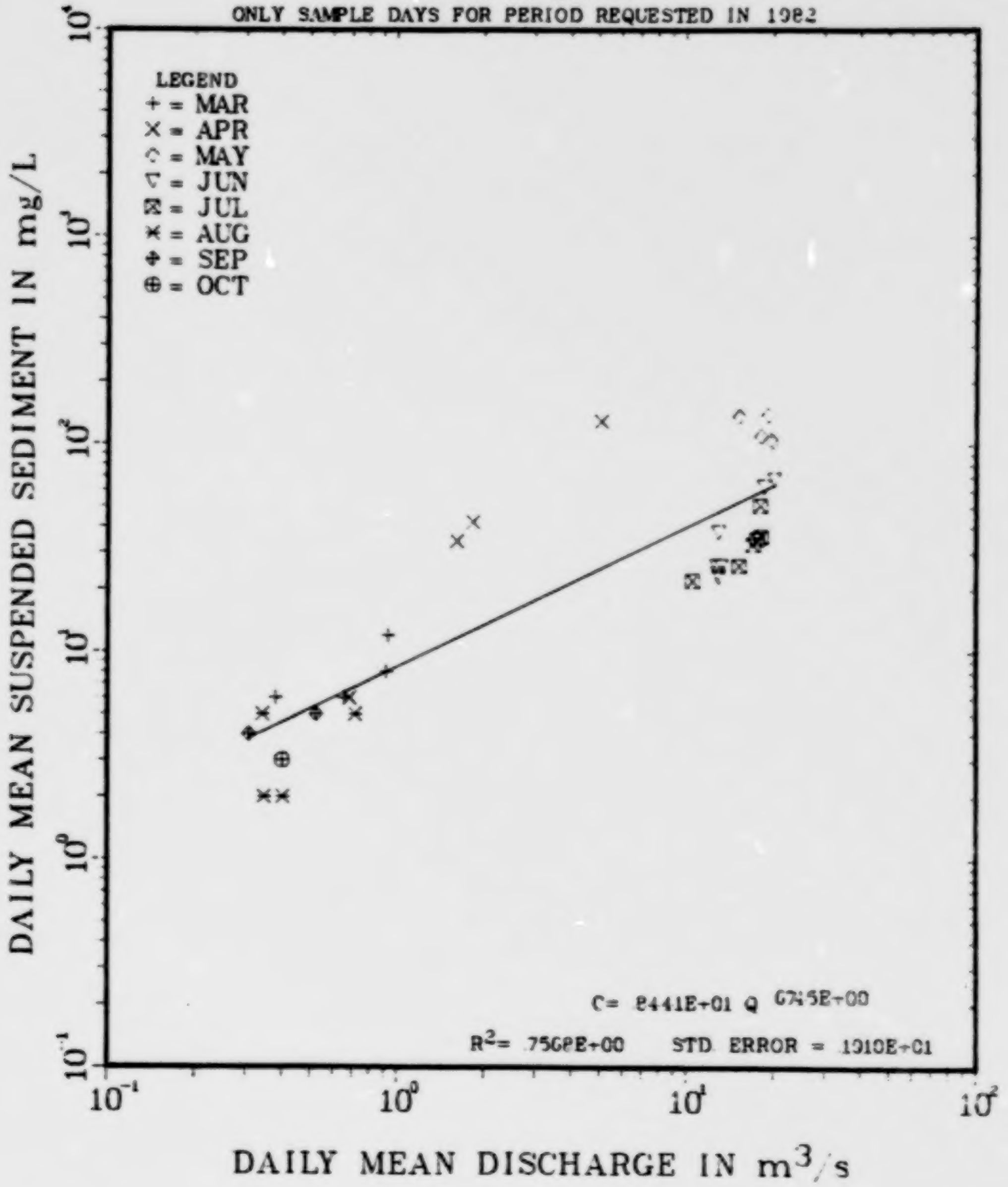
NORTH MILK RIVER NEAR INTERNATIONAL BOUNDARY
STATION NO. 11AA001
ONLY SAMPLE DAYS FOR PERIOD REQUESTED IN 1981



NORTH MILK RIVER NEAR INTERNATIONAL BOUNDARY

STATION NO. 11AA001

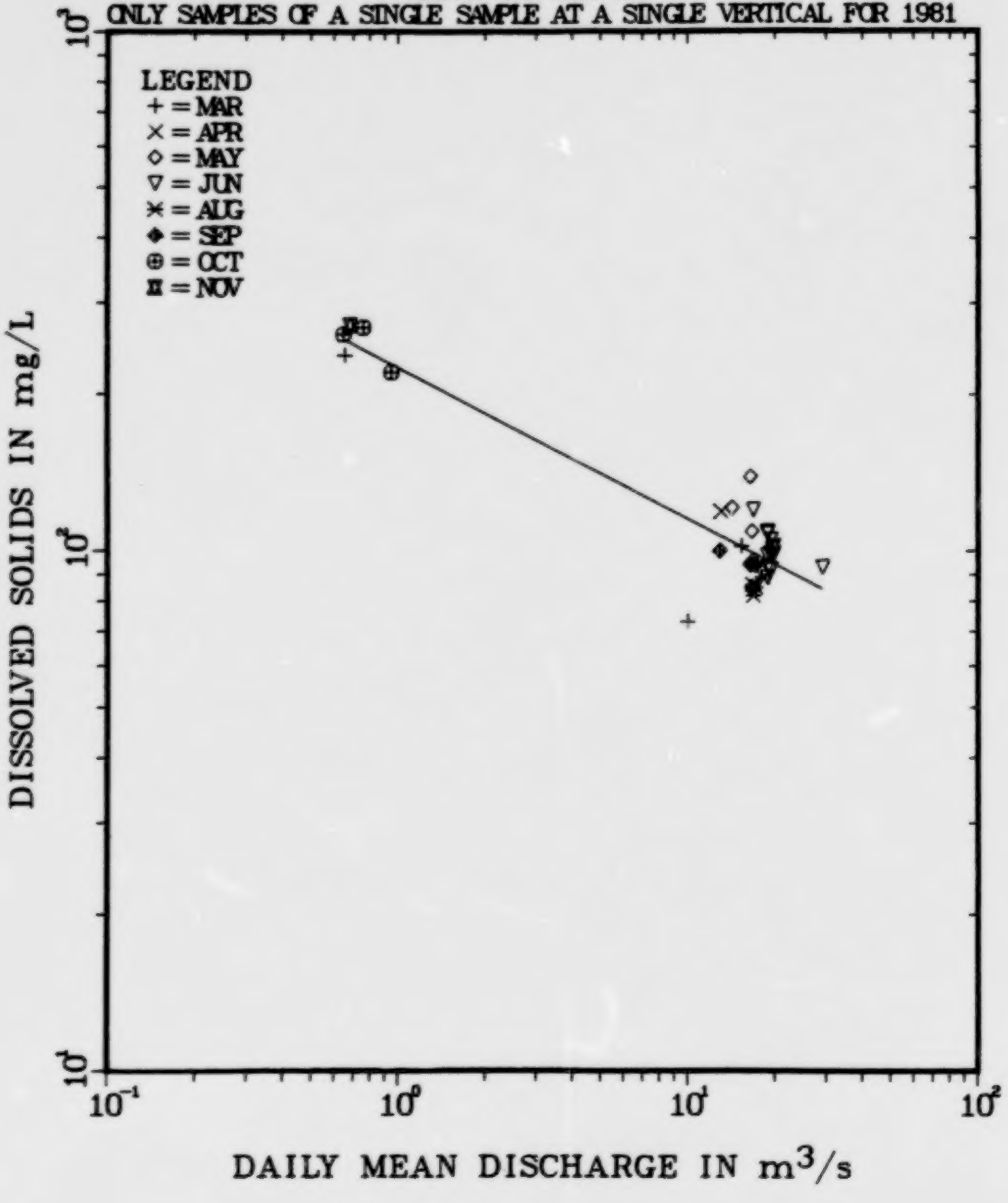
ONLY SAMPLE DAYS FOR PERIOD REQUESTED IN 1982



NORTH MILK RIVER NEAR INTERNATIONAL BOUNDARY

STATION NO. 11AA001

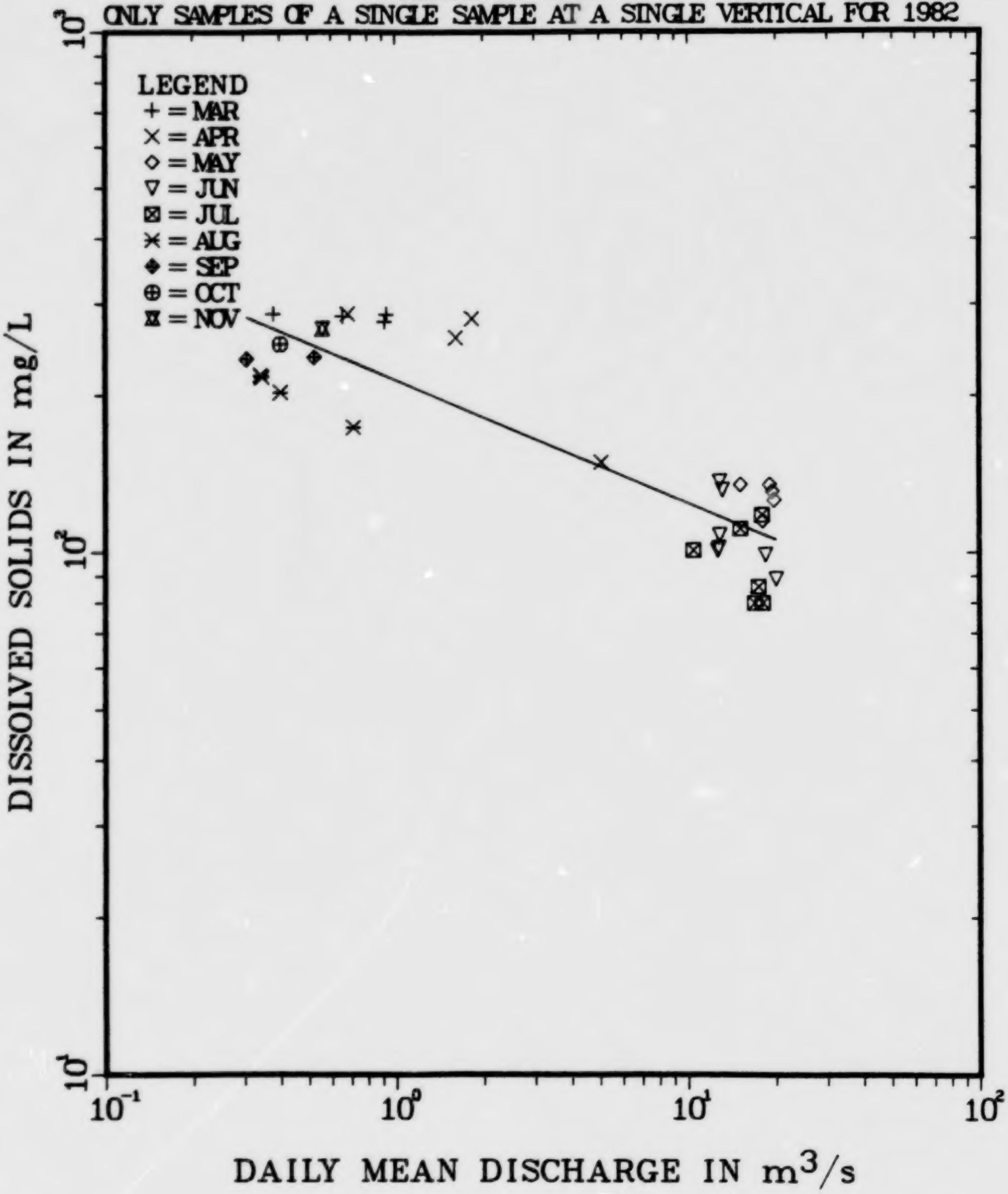
ONLY SAMPLES OF A SINGLE SAMPLE AT A SINGLE VERTICAL FOR 1981



NORTH MILK RIVER NEAR INTERNATIONAL BOUNDARY

STATION NO. 11AA001

ONLY SAMPLES OF A SINGLE SAMPLE AT A SINGLE VERTICAL FOR 1982



APPENDIX C

MILK RIVER AT WESTERN CROSSING

11AA025

TABLE OF CONTENTS

MILK RIVER AT WESTERN CROSSING

Page

1.0 HYDROMETRIC STATION DESCRIPTION C-4

1.1 Period of Record C-4
1.2 Gauging Station Description C-4
1.3 Channel and Valley Features C-4
Table C-1: River Valley, Flat and Channel Features ... C-7
1.4 Stereo Pair C-4
Figure C-1: Stereo Pair Aerial Photograph C-8
1.5 On Site Photographs C-5

2.0 HYDRAULIC DATA C-9

2.1 Rating Curve C-9
Figure C-2: Stage-Discharge Relation (1975 to 1986) .. C-9
2.2 Cross-Section C-10
Figure C-3A: Cross-Section at Cableway Section 700 Metres Below Gauge C-10
Figure C-3B: Cross-Section at Cableway 20 Metres Above Gauge C-11
2.3 Specific Gauge Diagram C-12
Figure C-4: Specific Gauge Diagram (1931 to 1986) C-12
2.4 Discharge versus Area; Mean Velocity; Mean Depth C-13
Figure C-5: Discharge versus Cross-Sectional Area C-13
Figure C-6: Discharge versus Mean Velocity............ C-13
Figure C-7: Discharge versus Mean Depth C-14
Table C-2: Hydraulic Data at Cableway C-14

3.0 SUSPENDED SEDIMENT DATA C-17

3.1 Period of Sampling and Frequency C-17
Table C-3: Number of Suspended Sediment Samples C-17
3.2 Sampling Location, Procedures and Equipment C-17
3.3 Representativity... C-17
Figure C-8: Recurrence Intervals of Total Seasonal Discharge (dam^3) C-18
3.4 Suspended Sediment Discharge Data C-18
Table C-4: Suspended Sediment Load Simulated by Regression Techniques C-19
Figure C-9: Suspended Sediment Concentration versus Discharges C-20

TABLE OF CONTENTS

MILK RIVER AT WESTERN CROSSING

Page

4.0 SUSPENDED SEDIMENT PARTICLE SIZE DATA C-21

Table C-5: Particle Size Analysis of Depth-Integrated Suspended Sediment Sample C-21
Figure C-9: Plot of Particle Size Information for a Suspended Sediment Sample C-22

5.0 BED MATERIAL DATA C-23

6.0 BED LOAD DISCHARGE DATA C-23

7.0 DISSOLVED SOLIDS DATA C-23

DIAGRAMS AND TABLES OF DATA C-24

- Station Description C-24
- Flow Duration Curve C-25
- Streamflow and Sediment Hydrographs C-26
- Instantaneous Suspended Sediment and Dissolved Solids Data .. C-29
- Annual Suspended Sediment Rating Curves C-32
- Dissolved Solids versus Discharge Plots C-37

MILK RIVER AT WESTERN CROSSING: 11AA025

1.0 HYDROMETRIC STATION DESCRIPTION

1.1 PERIOD OF RECORD

This gauging station was established in September 1930 in the NW.6-1-19-W.4. It was moved 100 metres downstream in August 1948 where it remained until September 1958, when it was moved to its present location in the NE.1-1-20-W.4.

The period of operation for this station has been a March to October season from 1931 to the present.

1.2 GAUGING STATION DESCRIPTION

The present gauging station is located on the left bank in the NE.1-1-20-W.4. The station consists of a 1.5 metre wood stave culvert stilling well linked to the stream by metal pipe intakes. The well is capped with a standard metal walk-in shelter which houses a Stevens A-71 float-operated strip chart recorder.

High flow (>12 m^3/s) streamflow discharge measurements are made from a cableway situated 20 metres above the gauge. Prior to 1976 this cableway was located 700 metres below the gauge. Lower flow measurements are made by wading, usually in the vicinity of the gauge, but they have also been made as much as 500 metres above the gauge.

A copy of the field man's station description can be found on page C-24.

1.3 CHANNEL AND VALLEY FEATURES

The significant features of the valley and river in the vicinity of the gauge are detailed in Table C-1. The data for this table were extracted from aerial photographs and from a personal knowledge of the site. The classification and interpretation is based on an abbreviated form of that developed by Kellerhals et al (1976).

1.4 STEREO PAIR

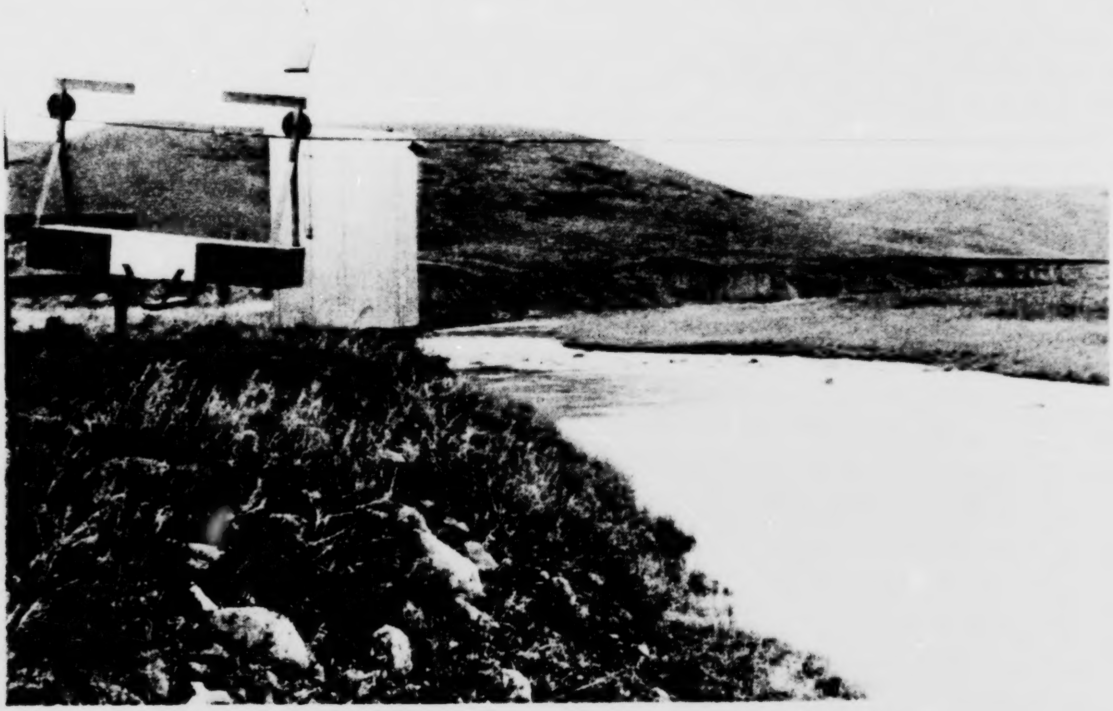
Figure C-1 is a stereo pair of the gauging station site. The photos were flown June 1978 and have a scale of 1:30 000.

1.5 ON SITE PHOTOGRAPHS

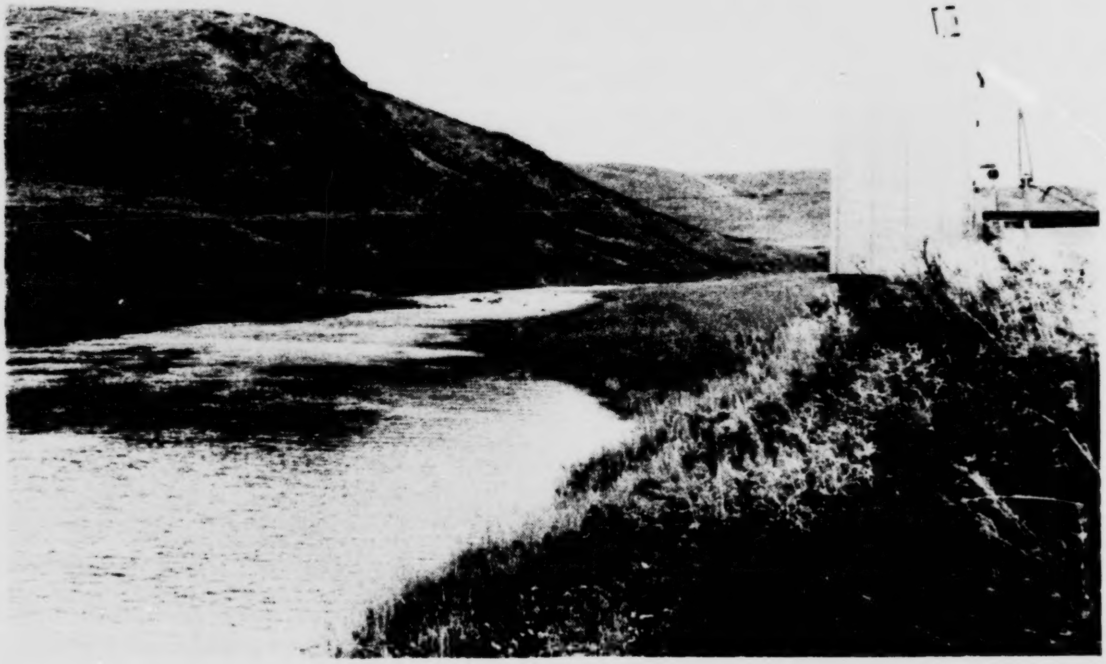
Milk River at Western Crossing

Looking Upstream. Gauge in the Centre, Slightly Right in Photograph

Typical Streambed: This Particular Site Located
200m Upstream of Gauge.



Looking Downstream
Milk River at Western Crossing



Looking Upstream

TABLE C-1

MILK RIVER AT WESTERN CROSSING

RIVER VALLEY, VALLEY FLAT AND CHANNEL FEATURES

GENERAL DESCRIPTION IN VINCITY OF HYDROMETRIC STATION (ABOVE VALLEY)	
Terrain	: Plains
Vegetation	: Grass
Land Use	: Partially Cultivated Left Bank No Cultivation Right Bank
VALLEY CHARACTERISTICS ABOVE VALLEY FLAT	
Slumping of Valley Walls	: Occasional
Vegetation on Valley Walls	: Grass
TERRACES	
Presence	: Fragmentary
Number of Levels	: Several
RELATION OF CHANNEL TO VALLEY	
Valley Type	: Stream Cut Valley
Relation of Channel to Valley Bottom	: Partially Entrenched
Relation of Channel to Valley Walls or Resistant Terraces	: Frequently Confined
DESCRIPTION OF VALLEY FLAT	
Presence	: Fragmentary
Extent	: Moderate (1 to 5 channel widths)
Vegetation	: Grass
Land Use	: Not Cultivated
CHANNEL DESCRIPTION	
Pattern	: Irregular
Islands	: None
Bar Type	: Point Bars
Type of Flow	: Uniform with Rapids in Reach
LATERAL CHANNEL ACTIVITY	
Lateral Activity	: Not Detectable
Lateral Stability	: Stable
CHANNEL BANK AND BEDS	
Alluvial Bank Material	: Cobbles Overlain by Silt
Bank Vegetation	: Grass, Small Shrubs
Predominant Bed Material	: Sand and Gravel to Cobbles

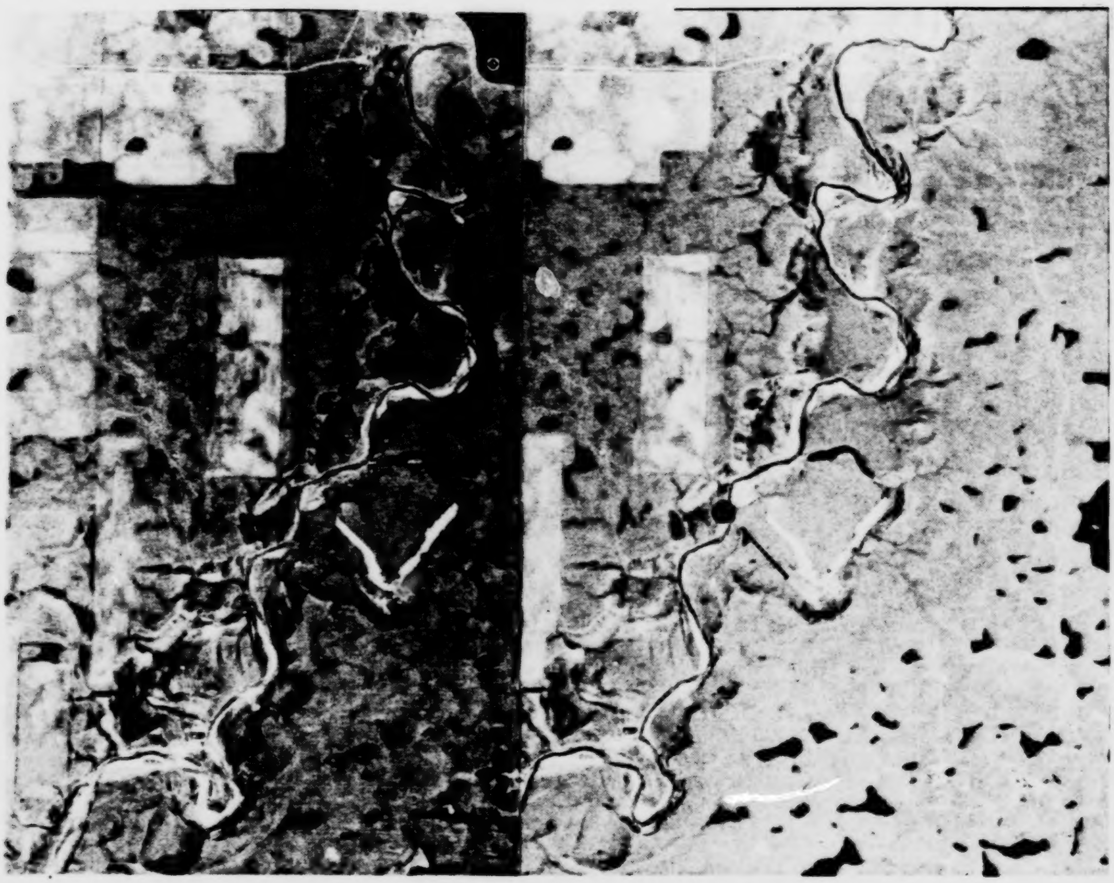


Figure C-1

Stereo Pair Aerial Photographs
Arrow Indicates Gauging Station Site
Milk River at Western Crossing

2.0 HYDRAULIC DATA

1.2 RATING CURVE

The stage-discharge relation at this gauging station is reproduced in Figure C-2. Curves No. 15 and 17 are indicated on this figure and one or the other has been used since 1975. In spite of the high designation of the curves (sequential increase in number for each new curve) the curve of relation is relatively stable and each change in

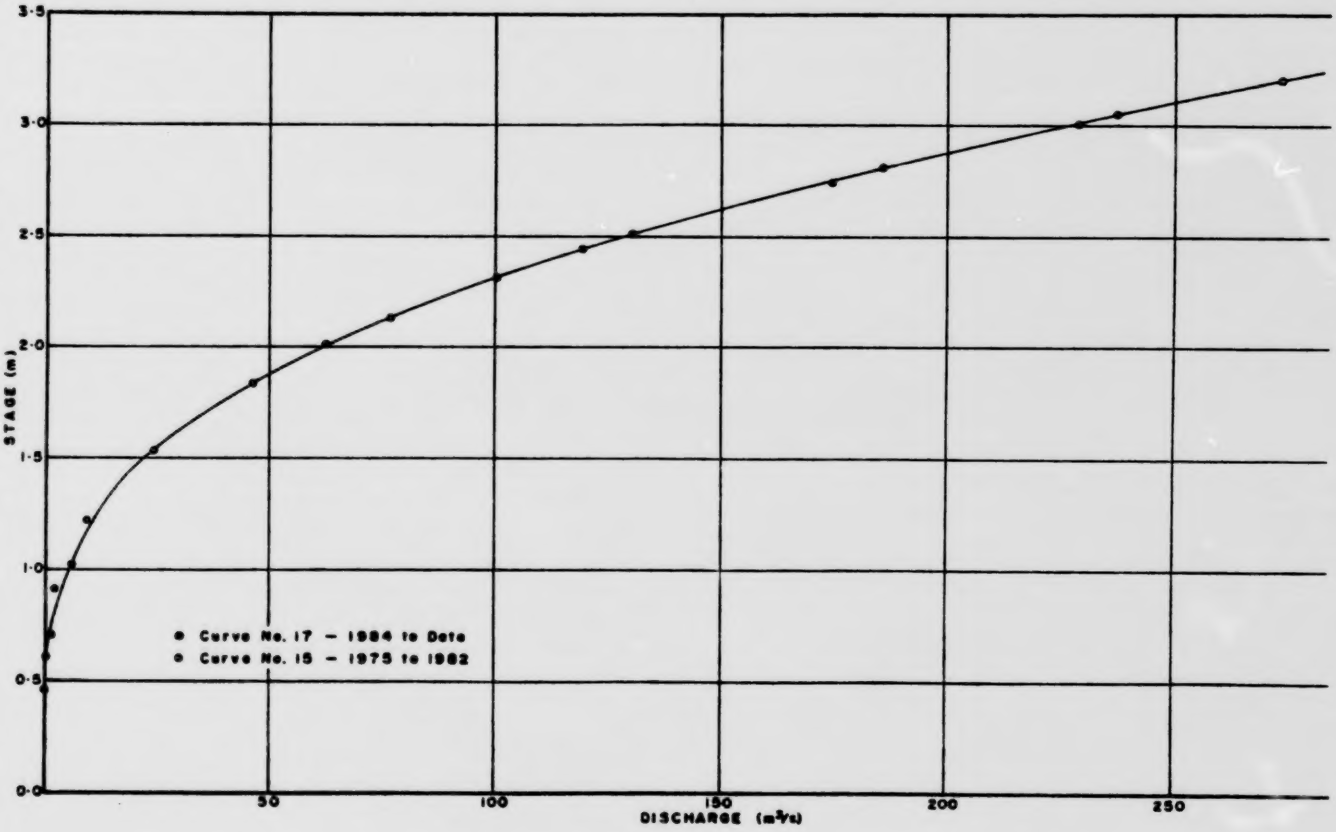


Figure C-2

Stage-Discharge Relationship (1975 to 1986)
Milk River at Western Crossing

the curve was either because of gauge relocation, for minor changes in the low water control, or because of definition of certain areas of the curve by streamflow discharge measurements where measurements had previously not been made.

2.2 CROSS-SECTIONS

The cross-sections depicted in C-3A and C-3B are for the former cableway section (700 m below gauge) and the present cableway section, (20 m above gauge) respectively. The two streamflow discharge measure

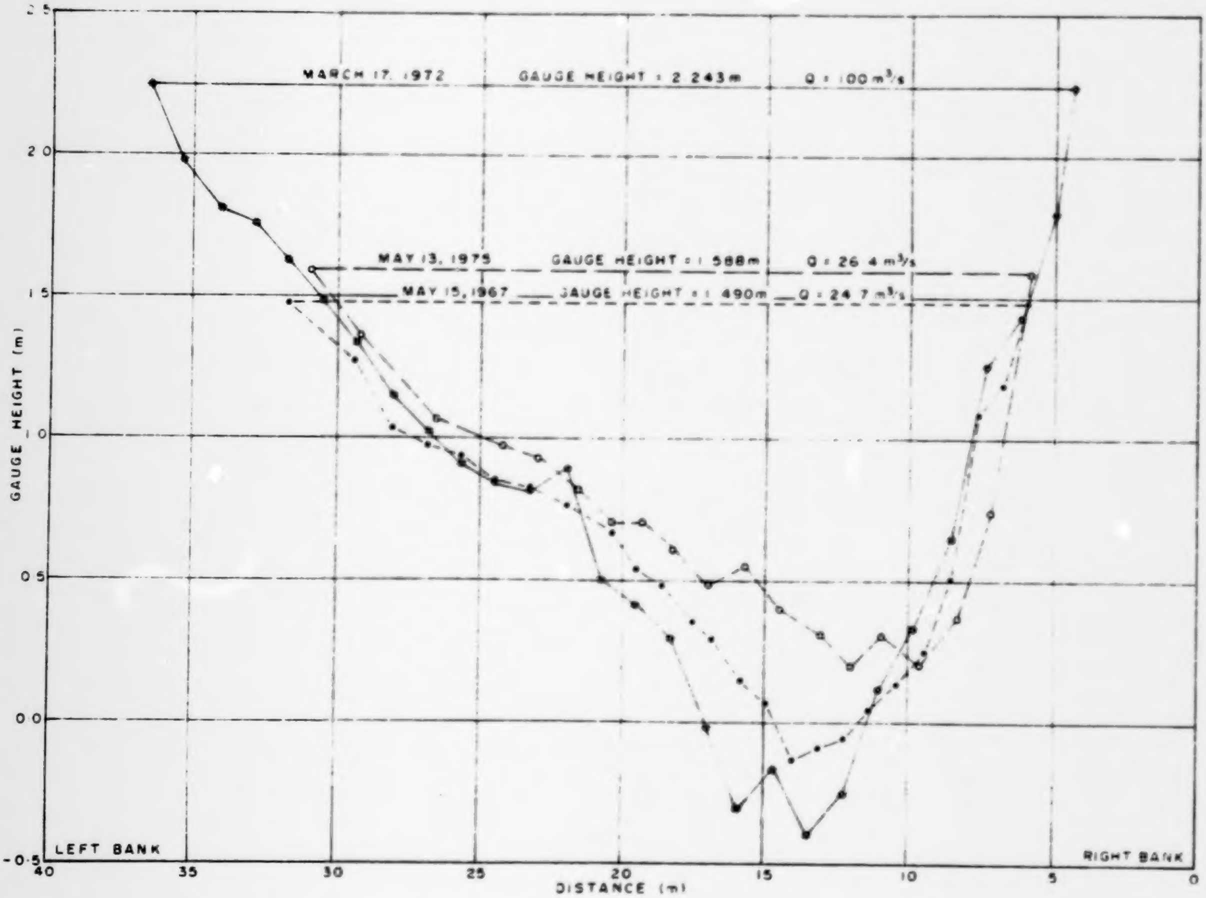


Figure C-3A

Cross-Section at Cableway Section 700 Metres Below Gauge
Milk River at Western Crossing

ments (March 28, 1978 and February 26, 1986), utilized to produce the cross-section in Figure C-3B, reinforce the comments in Section 2.1 regarding the stability of the stream; that is, only small changes have taken place over the nine year period of record. Conversely, the cross-sections in C-3A (three measurements over a nine year period) indicate significant changes taking place in the stream bottom during the period 1967 to 1975 with changes of over 0.5 metres taking place.

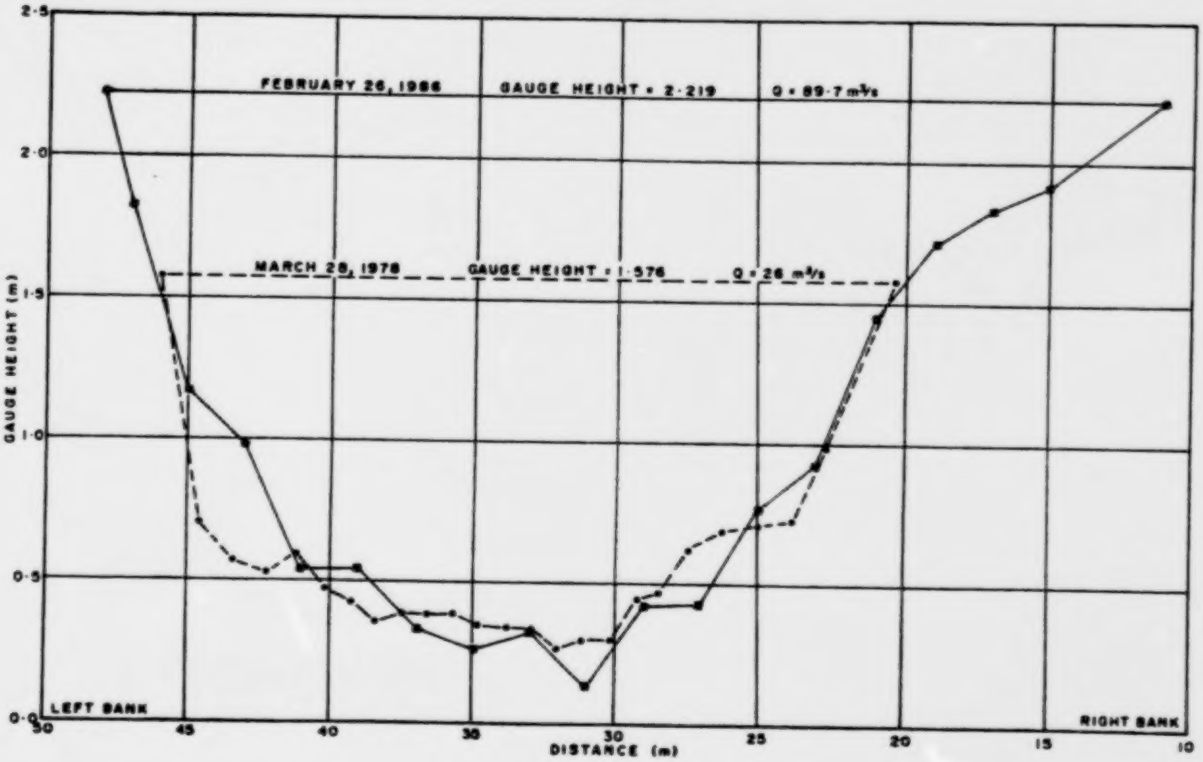


Figure C-3B

Cross-Section at Cableway 20 Metres above Gauge
Milk River at Western Crossing

2.3 SPECIFIC GAUGE DIAGRAM

Figure C-4 is a specific gauge plot for the period of record from 1931 to 1986. This diagram shows the corresponding gauge heights for two separate flows (1 and 5 m^3/s) throughout the period of record.

The diagram immediately focusses attention on the abrupt changes between 1947-48, 1953-54 and 1958-59. The changes in 1947-48 and 1958-59 were as the result of gauge relocations, whereas the change in 1953-54 was as a result of a gauge datum change of 0.3 metres.

With the exception of actual changes to the gauging station, the remainder of the diagram indicates no significant aggradation or degradation has taken place during the period of record. This further corroborates statements in sections 2.1 and 2.2, indicating that the stream channel at this location is relatively stable.

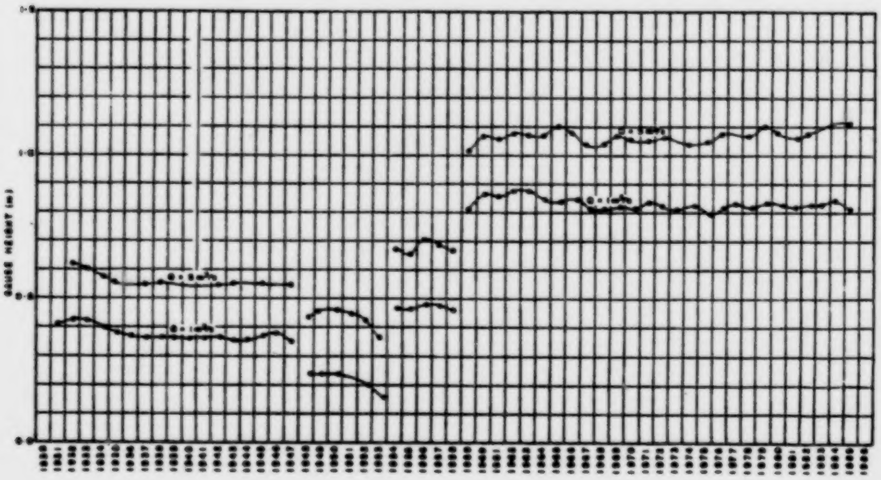


Figure C-4

Specific Gauge Diagram: 1931 to 1986
Milk River at Western Crossing

2.4 DISCHARGE VERSUS AREA; MEAN VELOCITY; MEAN DEPTH

Plots of discharge versus cross-sectional area, discharge versus mean velocity in the cross-section, and discharge versus mean depth in the cross-section are reproduced in Figures C-5 to C-7, respectively. Data for both cableway sections are included and are distinguished by separate symbols. The data were extracted from streamflow discharge measurement notes and are tabulated in Table C-2.

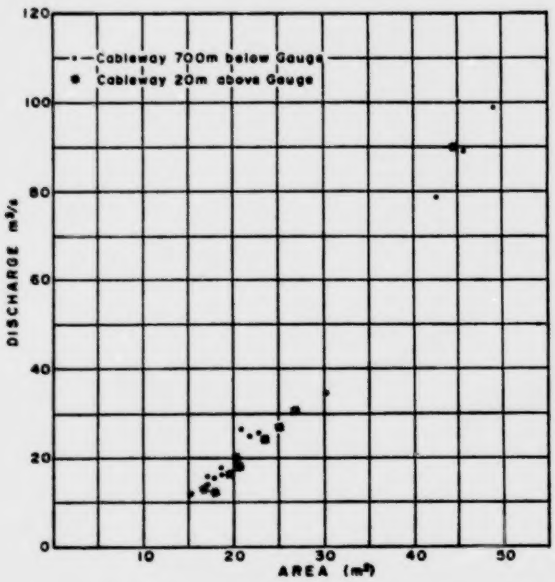


Figure C-5

Discharge versus Cross-Sectional Area

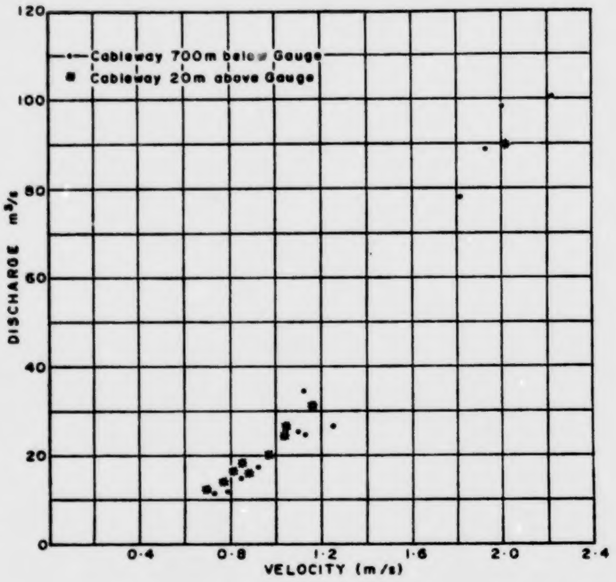


Figure C-6

Discharge versus Mean Velocity

Milk River at Western Crossing

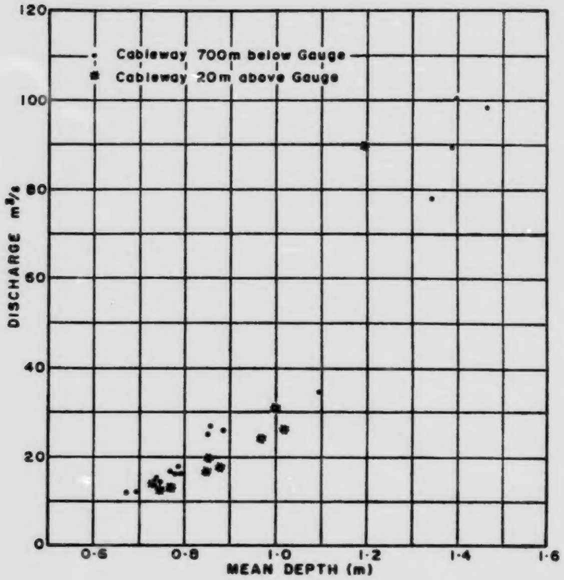


Figure C-7

Discharge Versus Mean Depth
Milk River at Western Crossing

Table C-2

MILK RIVER AT WESTERN CROSSING

HYDRAULIC DATA AT CABLEWAY

Date	Discharge m^3/s)	Gauge Height (m)	Mean Velocity (m/s)	Area (m^2)	Width (m)	Mean Depth (m)
Cableway 20m Above Gauge						
1986						
Feb. 26	89.7	2.219	2.016	44.5	37.0	1.20
Feb. 28	13.9	1.320	0.799	17.4	23.5	0.74
1985						
Apr. 4	12.6	1.364	0.704	17.9	24.0	0.75

TABLE C-2 (cont'd.)

Date	Discharge m^3/s)	Gauge Height (m)	Mean Velocity (m/s)	Area (m^2)	Width (m)	Mean Depth (m)
1982						
Apr. 15	24.1	1.579	1.03	23.4	24.1	0.97
1980						
Apr. 17	19.6	1.465	0.961	20.4	23.8	0.86
May 17	30.9	1.698	1.157	26.7	27.1	0.99
1979						
Apr. 17	12.2	1.292	0.686	17.8	23.2	0.77
Mar. 29	26.0	1.576	1.040	25.0	24.4	1.02
1978						
Mar. 29	17.5	1.460	0.844	20.7	23.5	0.88
Mar. 31	16.1	1.439	0.817	19.7	23.2	0.85
Cableway 700m Below Gauge						
1975						
Apr. 29	15.1	1.378	0.881	17.2	23.2	0.74
May 13	26.4	1.588	1.259	21.0	24.4	0.86
June 20	88.9	2.237	1.935	45.8	33.0	1.39
June 21	98.3	2.295	2.006	49.1	33.5	1.47
June 22	34.3	1.670	1.128	30.4	27.7	1.10
June 24	15.5	1.335	0.820	18.9	23.8	0.79
1972						
Mar. 17	100.	2.243	2.225	45.1	32.3	1.40
Mar. 21	17.1	1.420	0.917	18.7	23.8	0.79
Mar. 23	11.1	1.289	0.716	15.5	23.2	0.67
May 18	15.9	1.359	0.884	17.9	23.2	0.77
June 13	11.6	1.274	0.777	15.0	21.3	0.70
1969						
Apr. 10	13.4	1.311	0.786	17.0	22.6	0.75
1968						
Sept.24	15.1	1.347	0.844	17.9	22.9	0.78

TABLE C-2 (cont'd.)

Date	Discharge m^3/s)	Gauge Height (m)	Mean Velocity (m/s)	Area (m^2)	Width (m)	Mean Depth (m)
1967						
May 9	77.9	2.033	1.826	42.6	31.6	1.35
May 15	24.7	1.490	1.128	21.9	25.9	0.85
1966						
Mar. 31	25.1	1.570	1.094	22.9	25.6	0.89

3.0 SUSPENDED SEDIMENT DATA

3.1 PERIOD OF SAMPLING AND FREQUENCY

A miscellaneous suspended sediment sampling program was conducted at Milk River at Western Crossing during the years 1974 to 1976 and 1981 and 1982. Table C-3 details the number of samples taken.

TABLE C-3

MILK RIVER AT WESTERN CROSSING

NUMBER OF SUSPENDED SEDIMENT SAMPLES

YEAR	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	TOTAL
1974	-	-	2	1	1	1	1	1	7
1975	2	5	2	5	1	1	1	2	19
1976	1	1	1	1	1	1	1	1	8
1981	3	1	3	8	6	4	7	4*	36
1982	4	4	3	6	3	3	2	2*	27

* One sample taken in November.

3.2 SAMPLING LOCATION, PROCEDURES AND EQUIPMENT

During high flow (>11 m^3/s) periods, depth-integrated suspended sediment samples, using a DH-59 sampler, were taken from the cableway at mid-stream. At moderate flows (2 to 11 m^3/s) depth-integrated suspended sediment samples were obtained by wading to mid-stream and sampling with a DH-48 sampler. At low flows (<2 m^3/s) samples were obtained by direct dipping of the sample bottle into the stream. No suspended sediment discharge measurements were made.

3.3 REPRESENTATIVITY

Insufficient data was collected to compute sediment discharge data, using standard techniques, in any of the years in which samples were collected. Depth-integrated suspended sediment samples were collected to a high discharge of 98.3 m^3/s. During the period of record a peak discharge of 225 m^3/s was recorded. Samples have been taken at discharges at less than one-half of the peak with the third highest sampled flow being 34.3 m^3/s. Thus, the range of flows have not been adequately sampled to provide sufficient information on concentrations.

Figure C-8 is a flood frequency curve for Milk River @ Western Crossing, with the three largest discharges for which samples were collected, indicated on it.

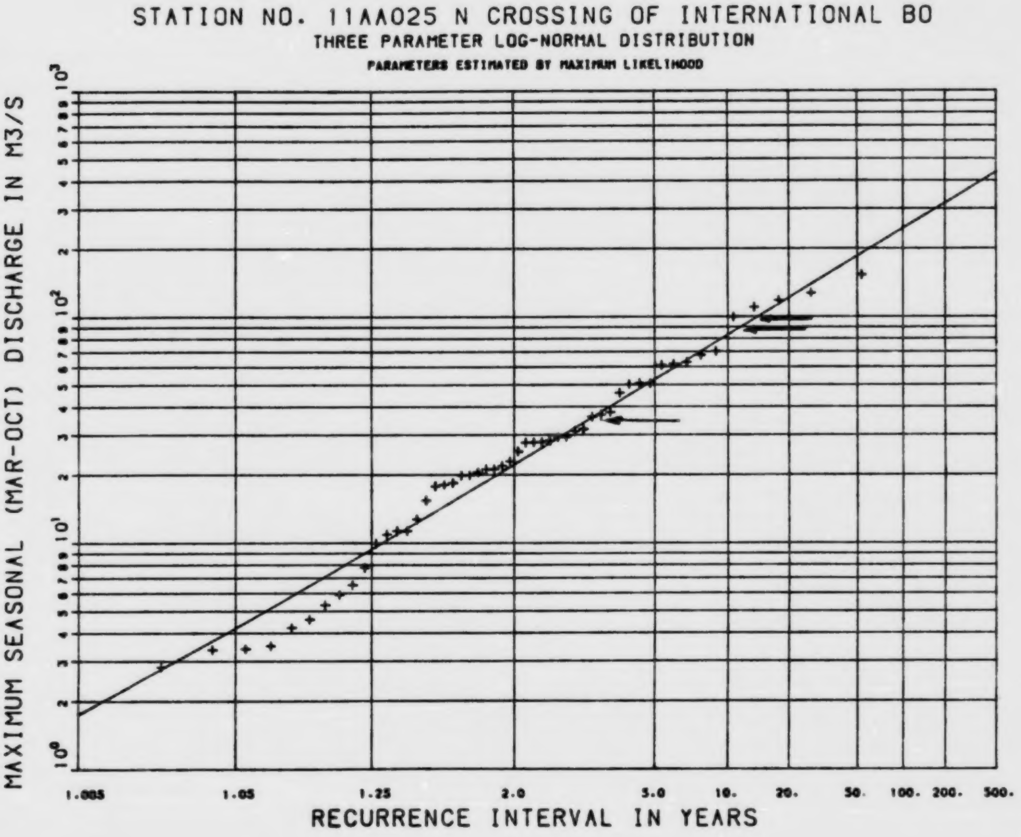


Figure C-8

Maximum Daily Discharge Flood Frequency
Milk River at Western Crossing

3.4 SUSPENDED SEDIMENT DISCHARGE DATA

Suspended sediment discharge data has been simulated by utilizing a sediment rating curve, based on the miscellaneous suspended sediment samples collected over the five year period. Plots of the sediment rating curves for individual years and the composite rating curve are located on pages C-32 to C-36 and the actual instantaneous data on which these are based can be found on pages C-29 to C-31. The simulated sediment discharge data is contained in Table C-4.

Viewing the combined rating curve on page C-20, it immediately becomes apparent that the computed generated regression equation will simulate sediment loads which are much too low, particularly at higher flows, which is concurrent with high sediment discharges. A hysteresis loop, as sketched, would produce much more reasonable results.

Pages C-26 to C-28 contain streamflow for the five years of discharge record with concentration of collected samples plotted on them. Page C-25 contains a flow duration curve for 1931 to 1984 and on this figure, in bar graph form, the number of samples taken in each 10% flow interval.

TABLE C-4

SUSPENDED SEDIMENT LOAD SIMULATED BY REGRESSION TECHNIQUE

WATER SURVEY OF CANADA
11/03/87 , PAGE 1
SEDIMENT SURVEY SECTION

MILK RIVER AT WESTERN CROSSING OF INTERNATIONAL BOUNDARY

STATION NO. 11AA025

TOTAL LOADS IN TONNES

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1960			2446	357	922	143	17	12	0	5			3902
1961			209	190	719	121	11	1	3	23			1277
1962			528	1382	349	137	10	5	1	13			2426
1963			94	120	118	229	124	0	0	0			683
1964			45	411	2204	6387	212	25	71	73			9427
1965			330	3649	1500	1426	263	41	133	57			7398
1966			981	837	468	1818	288	45	21	52			4521
1967			480	1044	6219	2861	259	36	10	33			10942
1968			348	356	906	730	110	71	473	140			3134
1969			315	5109	469	1309	375	11	4	39			7631
1970			35	451	2579	978	87	21	16	26			4195
1971			167	1930	1813	821	143	13	19	30			4936
1972			9042	1471	2282	1332	338	106	52	57			14680
1973			149	256	235	55	1	0	0	0			695
1974			210	1127	1265	402	80	30	13	19			3145
1975			18	706	4491	6499	911	178	73	183			13060
1976			555	1270	1071	320	57	55	4	16			3350
1977			12	247	35	2	0	0	1	7			303
1978			4829	685	1064	751	320	147	658	68			8521
1979			2061	1732	1709	329	44	12	3	10			5900
1980			76	1478	887	566	30	35	26	37			3136
1981			181	238	1882	745	82	15	1	24			3169
1982			64	3528	827	504	113	2	4	26			5068
1983			158	140	159	27	8	0	0	0			492
1984			52	92	37	40	1	0	0	1			221
1985			144	539	270	239	1	0	115	197			1505
MEAN			905	1130	1330	1110	149	33	65	44			4760
DEV.			1960	1240	1420	1700	196	46	154	53			3960

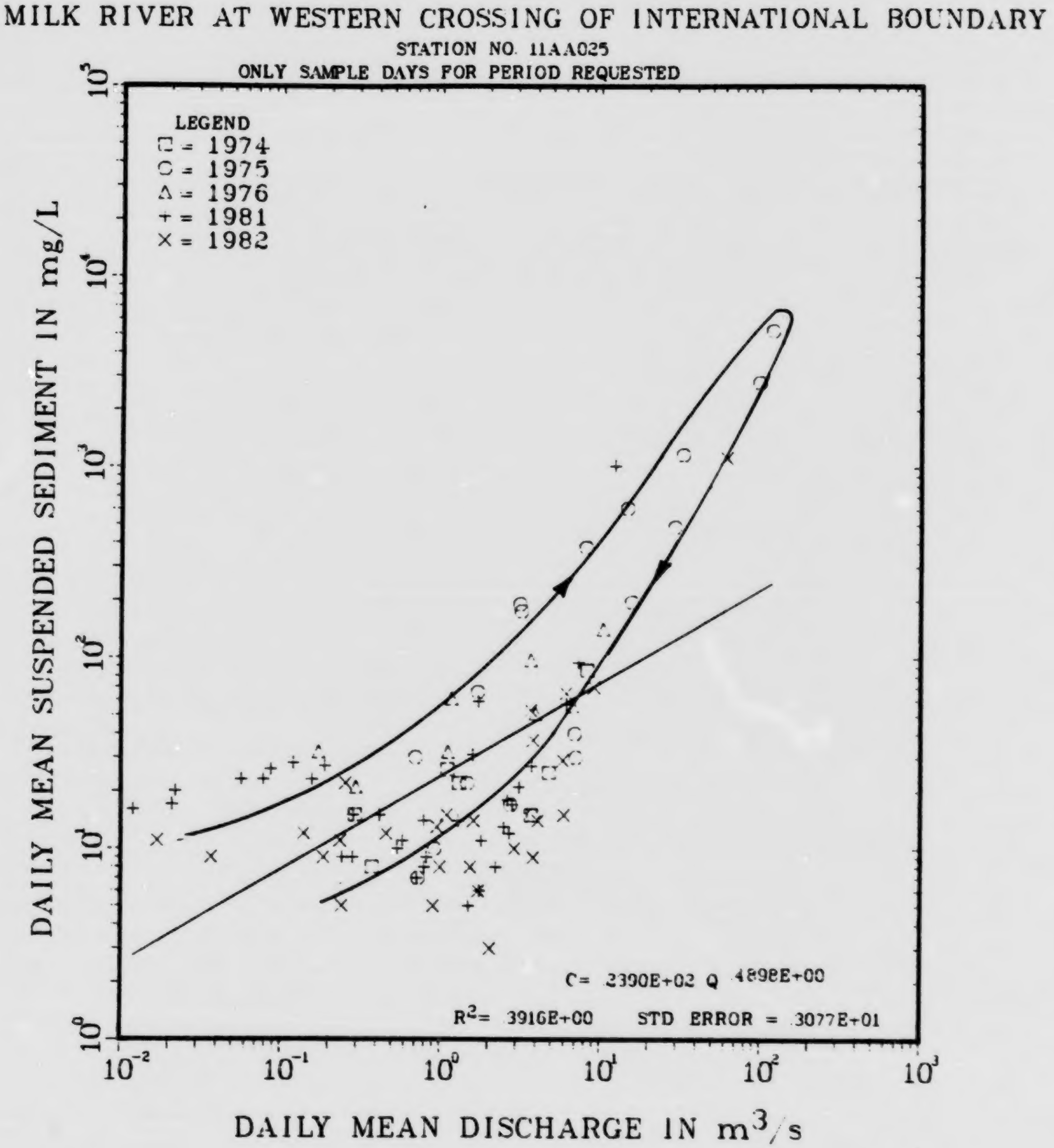


Figure C-9

Suspended Sediment Concentration versus Discharges

4.0 SUSPENDED SEDIMENT PARTICLE SIZE DATA

Only one suspended sediment sample was analyzed for particle size information. The information for this sample is contained in Table C-5 and depicted in Figure C-9.

TABLE C-5

PARTICLE SIZE ANALYSIS OF DEPTH-INTEGRATED SUSPENDED SEDIMENT SAMPLE

```
WATER SURVEY OF CANADA                  MILK RIVER AT WESTERN CROSSING OF INTERNATIONAL BOUNDARY                 STATION NO. 11AA025
 09/09/85 , PAGE  1
SEDIMENT SURVEY SECTION               DEPTH INTEGRATING PARTICLE SIZE ANALYSIS OF SUSPENDED SEDIMENT

SAMPLE IDENTIFIER   DISCHARGE      CONC.   PERCENT FINER THAN INDICATED SIZE, IN MICROMETRES  TOTAL        SAND          PERCENT
   DATE      TIME     (M3/S)      (MG/L)       2    4    8  16   31   62 125 250 500 1000 2000   D50   SDG    D50   SDG  CLAY  SILT  SAND

APR 14 1982  1325      60.0 M    1 120 K     13   20   32  46   63   81  92  98 100               17.5  5.4  103.9  1.8   20    61    19

DISCHARGE FOOTNOTE SYMBOLS                                   CONCENTRATION FOOTNOTE SYMBOLS
    M - DAILY MEAN                                               K - SAMPLE(S) COLLECTED IN A SINGLE VERTICAL

                                          SDG (GRADING) = SQUARE ROOT (D84/D16)
```

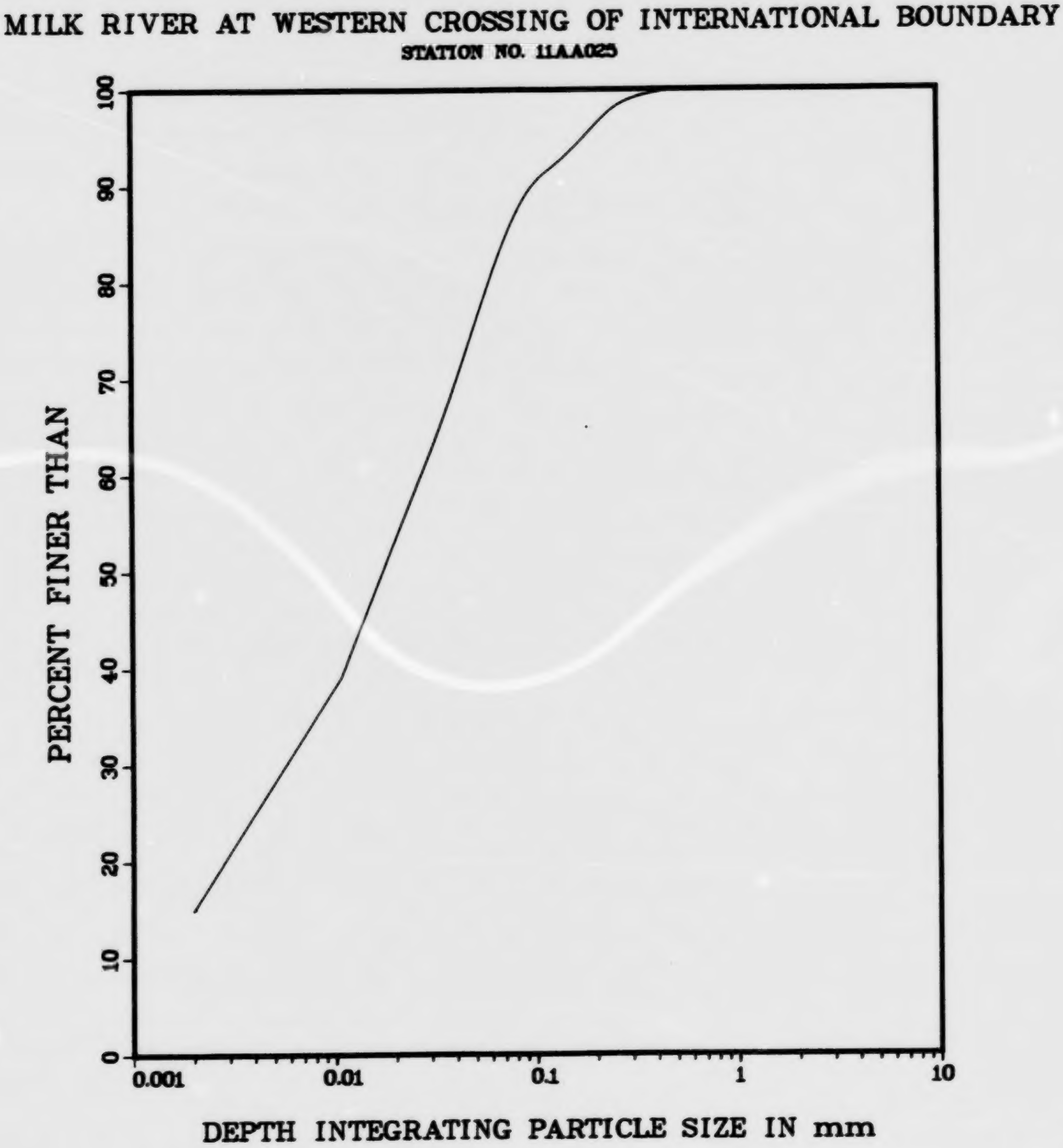


Figure C-9

Plot of Particle Size Information for a Suspended Sediment Sample.

5.0 BED MATERIAL DATA

No data available.

6.0 BED LOAD DISCHARGE DATA

No data available.

7.0 DISSOLVED SOLIDS DATA

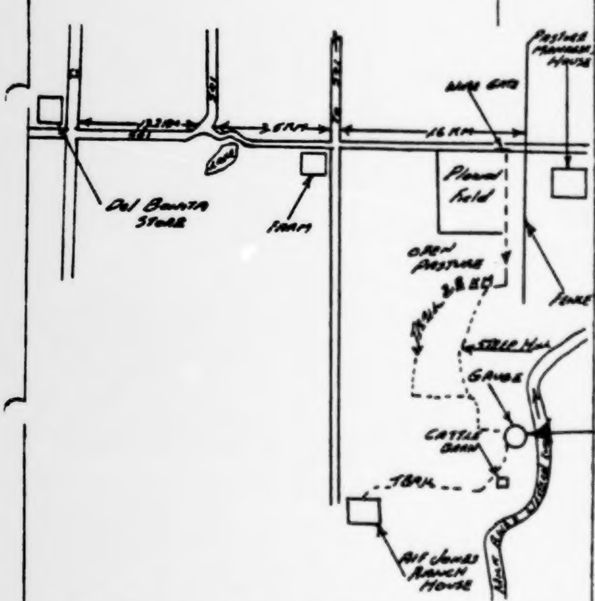
Information on dissolved solids is available as a by-product of the laboratory analysis for either suspended sediment concentration or for particle size. Dissolved solids data for 1981 and 1982 are depicted in plots of discharge versus dissolved solids concentration and can be found on pages C-37 and C-38. All available dissolved solids data are contained in tabular form and are located on pages C-29 to C-31.

WATER SURVEY OF CANADA - CALGARY

STATION DESCRIPTION

DETAILED SKETCH OF STATION LOCATION

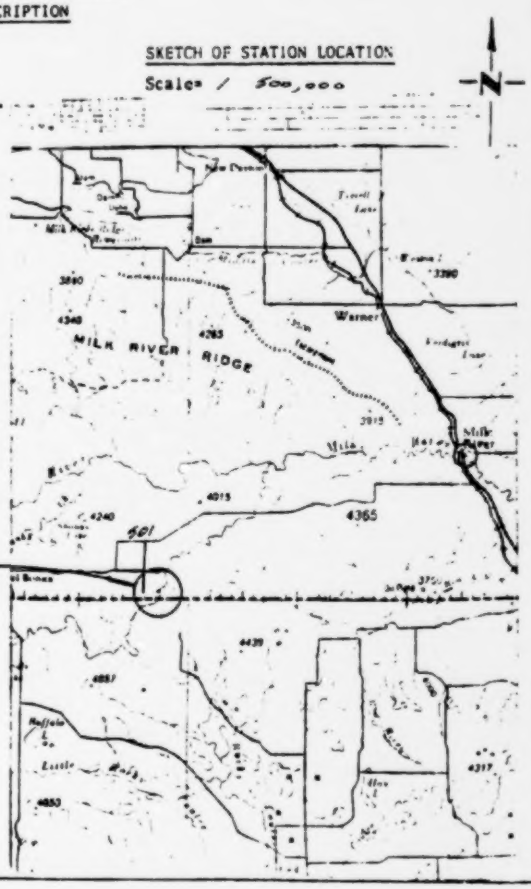
Scale= Not To Scale


N
Pasture Manager's House
Wire Gate
13.2 KM
501
5.1 KM
16 KM
Lake
Plowed Field
Del Bonita Store
Farm
Open Pasture
Trail 2.8 KM
Fence
Steep Hill
Gauge
Cattle Guard
TBM
Alf Jones Ranch House
Milk River

Upper intake - 0.08m diam. pipe 3m long. with coupling.
Elevation: 27.639
Lower intake - 0.08m diam. pipe, 4.9m long w/coupling.
Elevation: 27.093

SKETCH OF STATION LOCATION

Scale= 1/500,000


N
Milk River Ridge
Warner
Milk River
501
4365
4015
4240
3990
4340
4285
3915
4439
4857
4317
4450
Del Bonita
Little Bow

ORIGINAL

STATION DESCRIPTION

Station No. 11AA025 Basin

Station Name Milk River at Western Crossing of International Boundary

Located in NE 1/4 Sec. 1 Tp. 1 Rge. 20, W4th

Latitude 49°00'27" Longitude 112°32'42"

ReEstablished Sept.3/58 by Water Survey of Canada

Name of Observer Owner: Alf Jones

Address Del Bonita (Phone: 647-2114)

Rate of Pay Free Access Freq. of Obs.

Phone Alf Jones before going to station.

Location of station with respect to towns, etc:

From intersection of Hwy. #501 and Hwy. #62 (Del Bonita) go east 13.2 km, turn right, go east 5.1 km, follow trail south 2.8 km to gauge.

Description of gauge and equipment:

Recorder in Brytex shelter on 1.5m diameter well.

I.G. 0 - 3.7m and E.C.G.

Ght.Floor 3.70m

Measurement description:

High measurements are made from cableway 11m above gauge. I.P. right bank deadman. Marks are 1m marks with double marks at 10m intervals. Most mmnts. are made by wading 1 km above gauge.

Prepared by: RGH Date: October 19, 1983.

BENCH MARKS

Give elevation of bench marks, type, and number or markings, and gauge datum.

Gauge Datum= 26.600

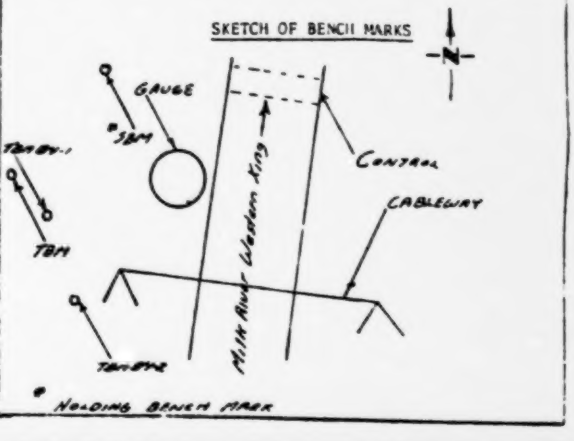
S.B.M. - 140m northwest of gauge.
Elevation: 30.180

T.B.M. - Iron pin 15.7m west of shelter and 40.5m southwest of S.B.M.
Elevation: 32.998 (Destroyed.

TBM 84-1 -T-Bar (painted red) located 16.5m [illegible] of gauge (marked with rock painted red)
Elevation: 30.283

TBM 84-2 -8m south of gauge on anchor rim (painted red) in deadman. This rim supports A/C warning cable.
Elevation: 30.299

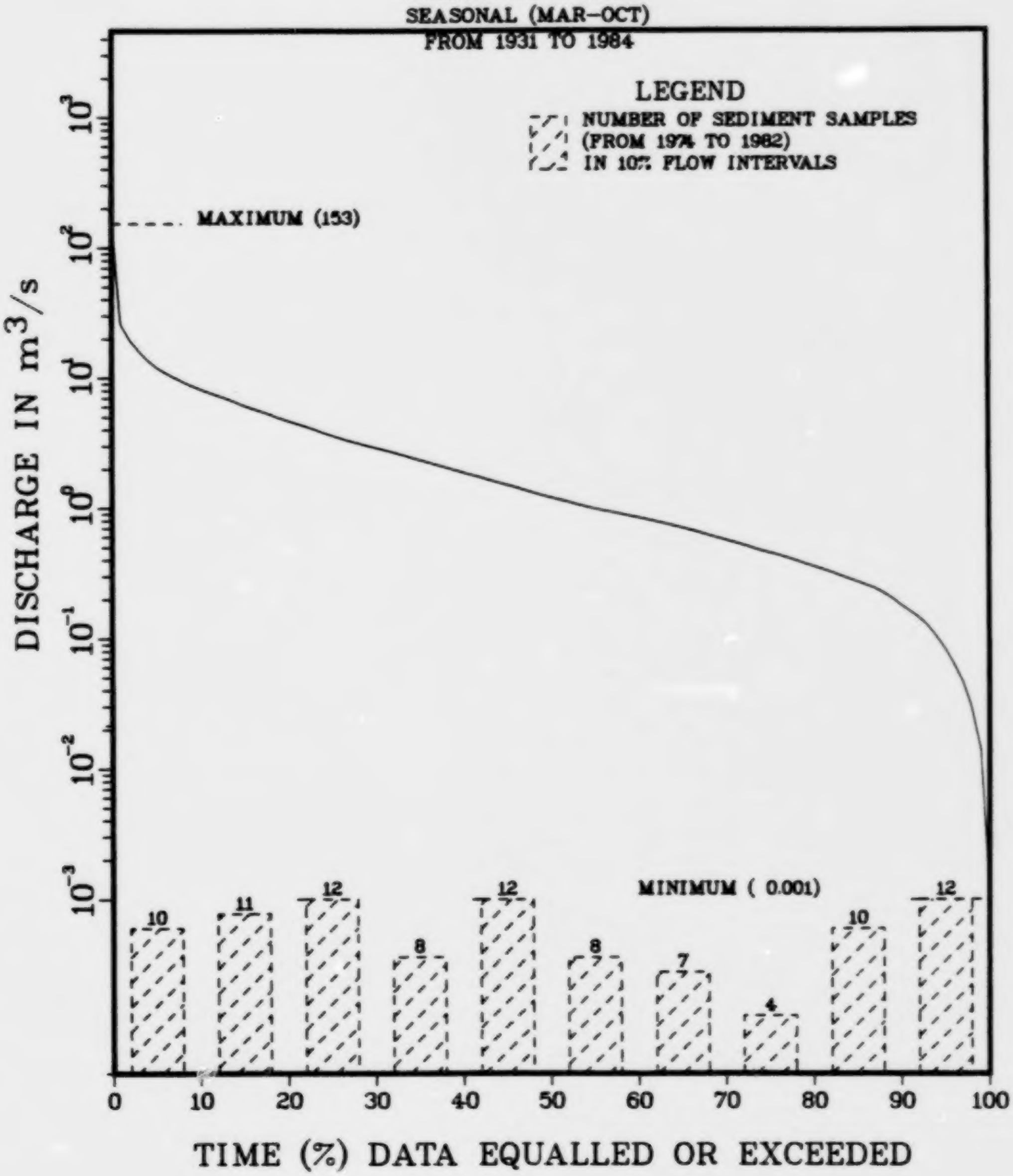
SKETCH OF BENCH MARKS

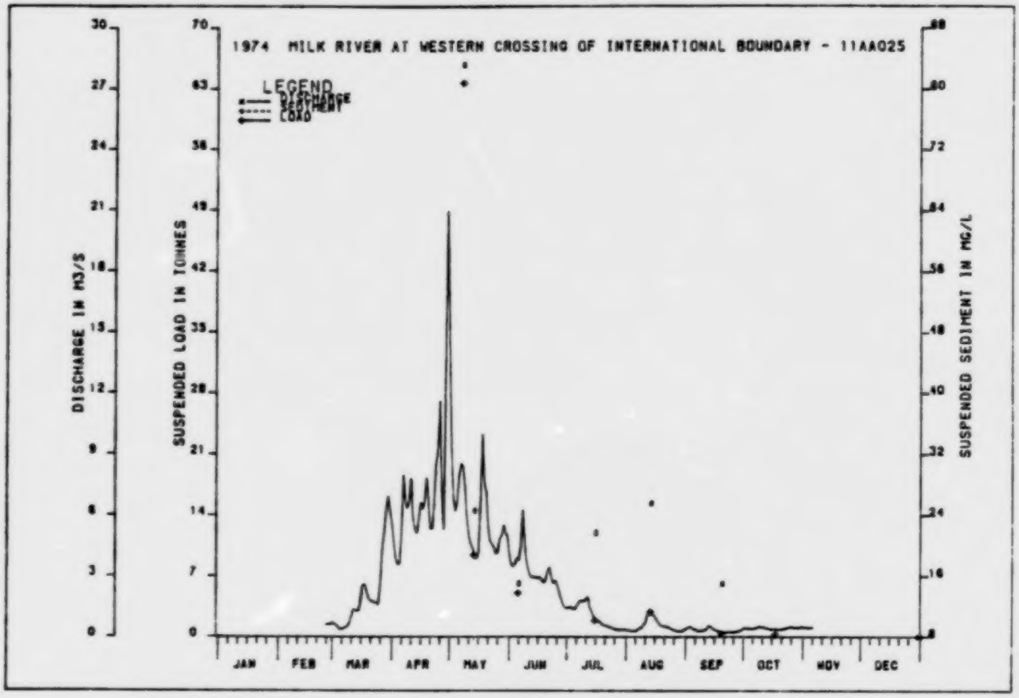

N
Gauge
SBM
TBM 84-1
TBM
Control
Cableway
Milk River Western Xing
TBM 84-2

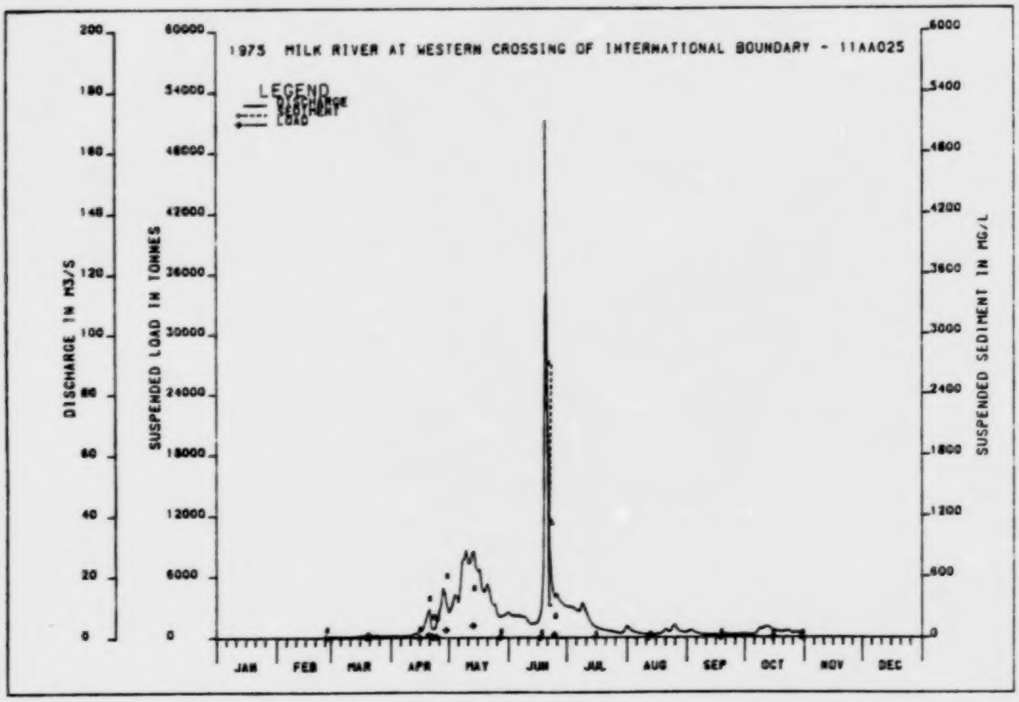
* Holding Bench Mark

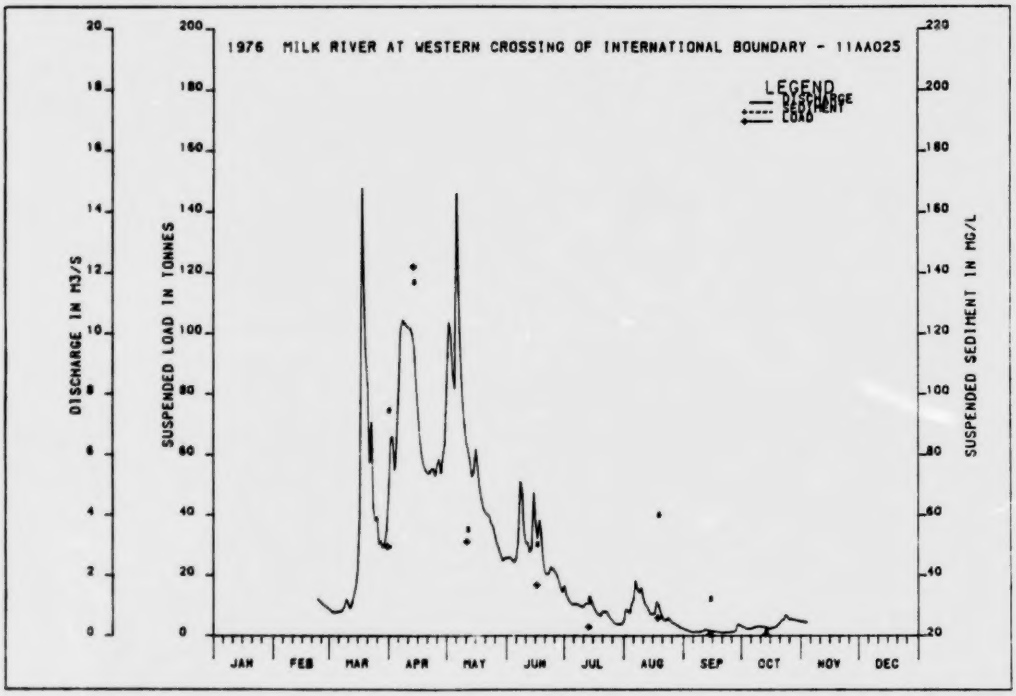
MILK RIVER AT WESTERN CROSSING OF INTERNATIONAL BOUNDARY

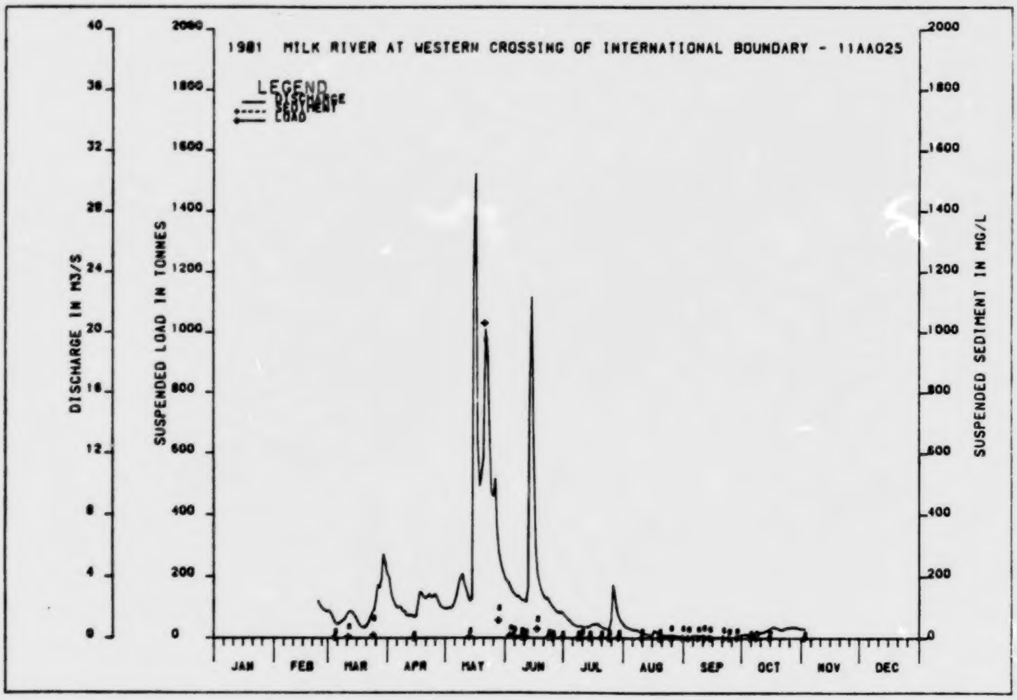
STATION NO. 11AA025
SEASONAL (MAR–OCT)
FROM 1931 TO 1984

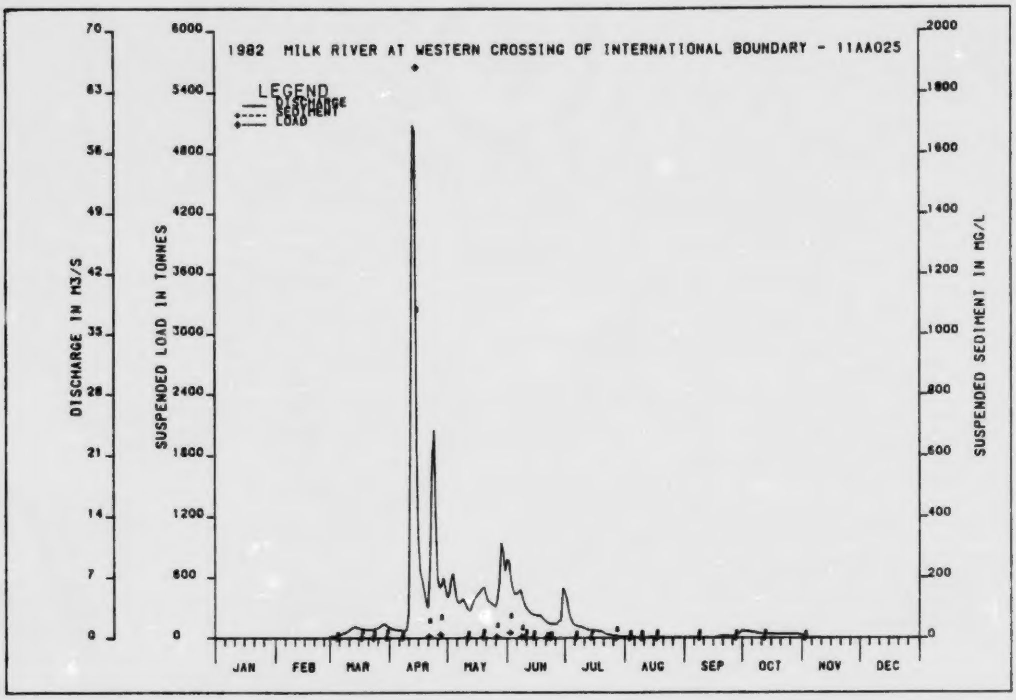



1974 MILK RIVER AT WESTERN CROSSING OF INTERNATIONAL BOUNDARY - 11AA025
LEGEND
DISCHARGE
SEDIMENT
LOAD
DISCHARGE IN M3/S
30
27
24
21
18
15
12
9
6
3
0
SUSPENDED LOAD IN TONNES
70
63
56
49
42
35
28
21
14
7
0
SUSPENDED SEDIMENT IN MG/L
88
80
72
64
56
48
40
32
24
16
8
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC


1975 MILK RIVER AT WESTERN CROSSING OF INTERNATIONAL BOUNDARY - 11AA025
LEGEND
DISCHARGE
SEDIMENT
LOAD
DISCHARGE IN M3/S
200
180
160
140
120
100
80
60
40
20
0
SUSPENDED LOAD IN TONNES
60000
54000
48000
42000
36000
30000
24000
18000
12000
6000
0
SUSPENDED SEDIMENT IN MG/L
6000
5400
4800
4200
3600
3000
2400
1800
1200
600
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC


1976 MILK RIVER AT WESTERN CROSSING OF INTERNATIONAL BOUNDARY - 11AA025
LEGEND
DISCHARGE
SEDIMENT
LOAD
DISCHARGE IN M3/S
SUSPENDED LOAD IN TONNES
SUSPENDED SEDIMENT IN MG/L
0
2
4
6
8
10
12
14
16
18
20
0
20
40
60
80
100
120
140
160
180
200
20
40
60
80
100
120
140
160
180
200
220
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC


1981 MILK RIVER AT WESTERN CROSSING OF INTERNATIONAL BOUNDARY - 11AA025
LEGEND
DISCHARGE
SEDIMENT
LOAD
DISCHARGE IN M3/S
SUSPENDED LOAD IN TONNES
SUSPENDED SEDIMENT IN MG/L
0
4
8
12
16
20
24
28
32
36
40
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
200
400
600
800
1000
1200
1400
1600
1800
2000
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC


1982 MILK RIVER AT WESTERN CROSSING OF INTERNATIONAL BOUNDARY - 11AA025
LEGEND
DISCHARGE
SEDIMENT
LOAD
DISCHARGE IN M3/S
0
7
14
21
28
35
42
49
56
63
70
SUSPENDED LOAD IN TONNES
0
600
1200
1800
2400
3000
3600
4200
4800
5400
6000
SUSPENDED SEDIMENT IN MG/L
0
200
400
600
800
1000
1200
1400
1600
1800
2000
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC

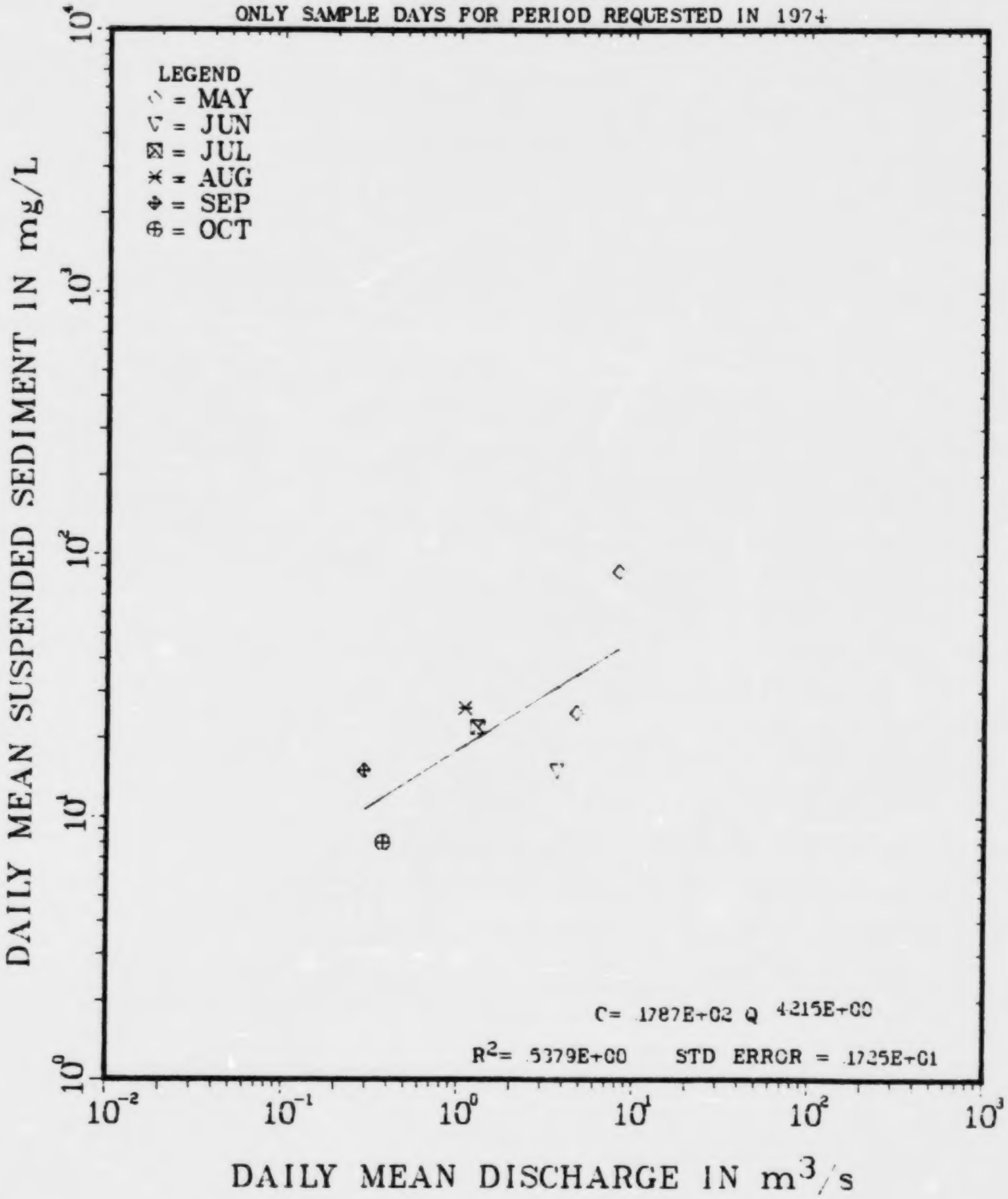
MILK RIVER AT WESTERN CROSSING OF INTERNATIONAL BOUNDARY

MONTH	DAY	TIME	DISSOLVED SOLIDS (mg/L)	INSTANTANEOUS CONCENTRATION (mg/L)	DISCHARGE (m^3/s)
		INSTANTANEOUS DATA FOR 1974			
MAY	7	1550	199	86	8.92
MAY	13	1510	190	25	4.96
JUN	5	1145	221	15	3.68
JUL	15	1410	182	22	1.21
AUG	13	1000	209	26	1.18
SEP	19	1630	230	15	0.286
OCT	17	1505	285	8	0.374
		INSTANTANEOUS DATA FOR 1975			
FEB	26	1015	266	57	0.082
MAR	18	1010	309	7	0.651
APR	15	1200	202	66	1.69
APR	20	1050	217	378	8.07
APR	22	1010	206	191	3.14
APR	24	0925	224	175	3.20
APR	29	1200	206	607	15.1
MAY	13	1245	194	485	26.4
MAY	27	1050	227	40	6.94
JUN	17	1015	216	30	6.37
JUN	20	1240	229	5229	88.9
JUN	21	1225	185	2800	98.3
JUN	22	1035	218	1158	34.3
JUN	24	1340	248	196	15.5
JUN	15	0740	269	15	3.65
AUG	12	1005	308	10	0.957
SEP	18	0930	326	30	0.677
OCT	15	1920	343	17	2.63
OCT	30	0850	365	22	1.48
		INSTANTANEOUS DATA FOR 1976			
MAR	31	0915	302	97	4.11
APR	13	1000	201	141	10.4
MAY	11	1130	260	56	6.63
JUN	16	1230	272	51	3.77
JUL	13	1520	268	32	1.16
AUG	18	0910	298	61	1.05
SEP	14	0940	420	32	0.178
OCT	13	1645	422	21	0.306

MONTH	DAY	TIME	DISSOLVED SOLIDS (mg/L)	INSTANTANEOUS CONCENTRATION (mg/L)	DISCHARGE (m^3/s)
		INSTANTANEOUS DATA FOR 1981			
MAR	4	1135	348	14	1.26
MAR	11	1450	313	31	1.61
MAR	24	1535	322	59	1.88
APR	14	1605	344	5	1.55
MAY	13	1115	317	17	2.79
MAY	21	1250	339	1014	10.5
MAY	28	1110	326	94	7.45
JUN	3	0930	303	27	3.67
JUN	5	0830	297	21	3.05
JUN	9	1120	289	18	2.49
JUN	11	0835	293	13	2.40
JUN	17	1800	319	57	5.65
JUN	23	1130	295	12	2.78
JUN	25	1120	286	8	2.26
JUN	30	0925	294	6	1.85
JUL	8	1200	285	8	0.827
JUL	10	0945	301	14	0.808
JUL	14	1650	290	7	0.704
JUL	20	1145	264	9	0.845
JUL	24	0925	279	11	0.542
JUL	29	1200	252	11	2.04
AUG	10	1110	427	15	0.385
AUG	19	1315	382	15	0.303
AUG	25	1545	333	27	0.204
AUG	31	1210	422	26	0.125
SEP	3	1130	446	23	0.051
SEP	8	1240	448	23	0.161
SEP	11	0830	551	28	0.119
SEP	14	1515	680	23	0.078
SEP	21	1135	676	20	0.015
SEP	24	0945	686	16	0.021
SEP	28	1130	692	17	0.021
OCT	5	1200	1234	9	0.016
OCT	8	0820	812	9	0.278
OCT	15	1325	537	10	0.510
NOV	2	1435	403	6	0.597
		INSTANTANEOUS DATA FOR 1982			
MAR	4	1325	429	5	0.242
MAR	17	1600	338	15	1.10
MAR	23	1250	366	8	0.996
MAR	30	1525	415	14	1.62

MONTH	DAY	TIME	DISSOLVED SOLIDS (mg/L)	INSTANTANEOUS CONCENTRATION (mg/L)	DISCHARGE (m^3/s)
		INSTANTANEOUS DATA FOR 1982 (cont'd.)			
APR	7	1030	429	5	0.906
APR	15	1325	192	1119	24.1
APR	21	1015	282	53	3.87
APR	27	1300	231	65	4.88
MAY	11	1610	265	9	3.77
MAY	19	1015	-	14	5.85
MAY	19	1345	262	16	6.07
MAY	26	1715	262	37	3.94
JUN	2	1215	277	70	9.54
JUN	8	1230	-	29	6.00
JUN	10	0950	294	14	4.13
JUN	14	1500	289	10	2.89
JUN	21	1250	278	3	2.01
JUN	23	1010	283	6	1.78
JUL	6	1745	328	8	1.51
JUL	14	0930	300	13	0.984
JUL	27	1230	332	22	0.264
AUG	3	1210	381	9	0.194
AUG	9	1140	466	9	0.038
AUG	17	1350	474	12	0.134
SEP	8	1030	665	11	0.017
SEP	27	1430	548	11	0.251
OCT	12	1520	354	12	0.470
NOV	2	1220	398	7	0.311

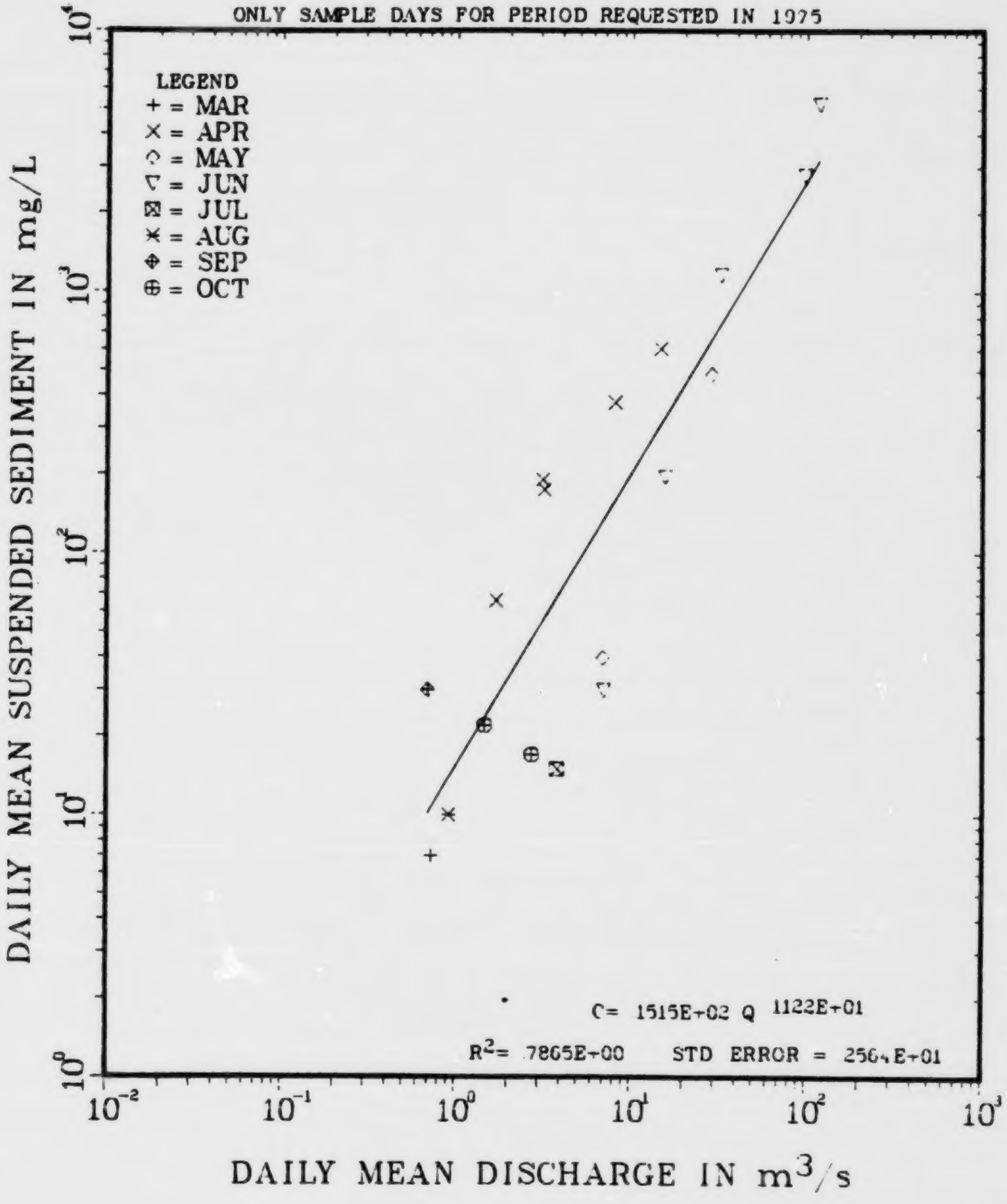
MILK RIVER AT WESTERN CROSSING OF INTERNATIONAL BOUNDARY
STATION NO. 11AA025
ONLY SAMPLE DAYS FOR PERIOD REQUESTED IN 1974



MILK RIVER AT WESTERN CROSSING OF INTERNATIONAL BOUNDARY

STATION NO. 11AA025

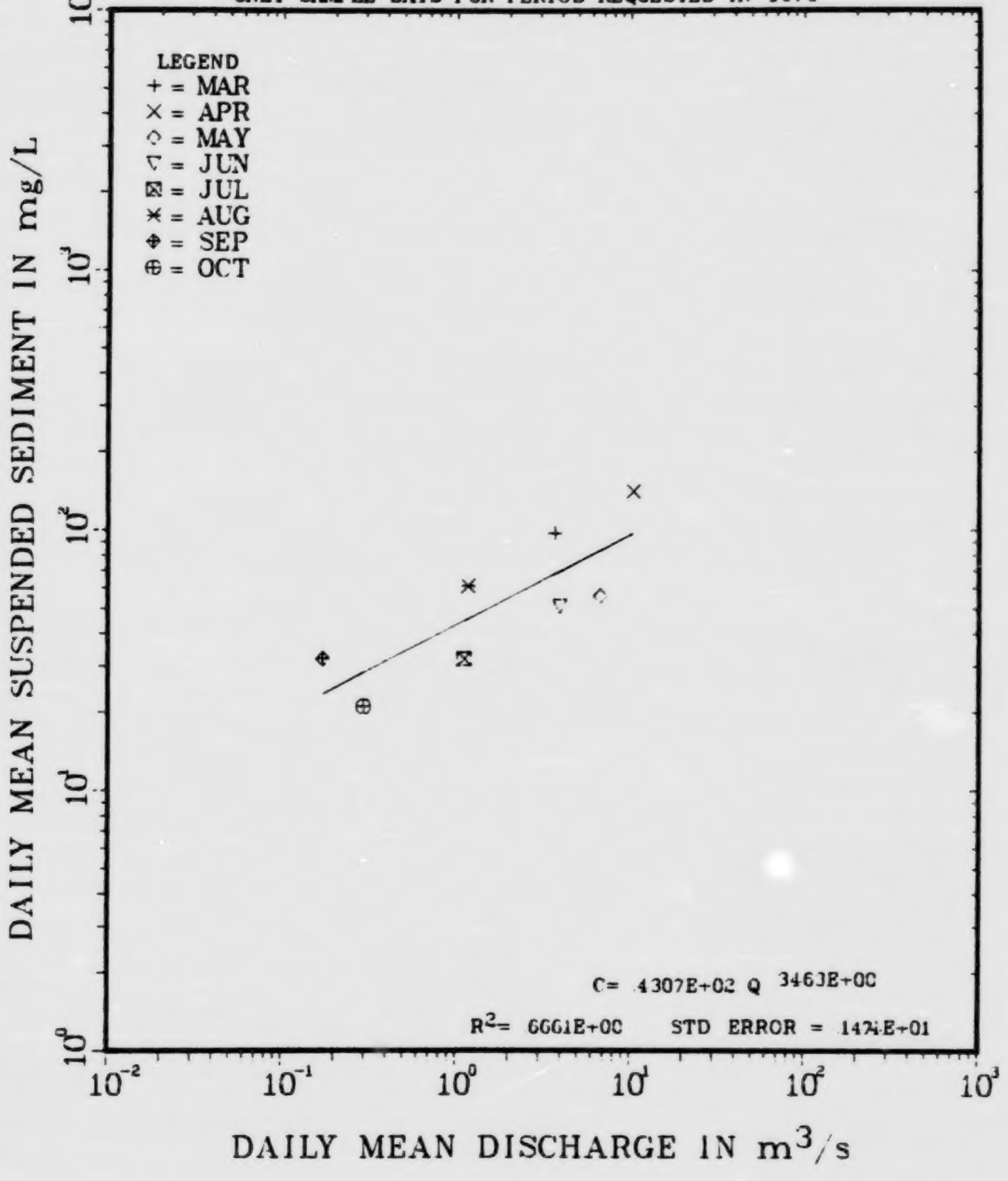
ONLY SAMPLE DAYS FOR PERIOD REQUESTED IN 1975



MILK RIVER AT WESTERN CROSSING OF INTERNATIONAL BOUNDARY

STATION NO. 11AA025

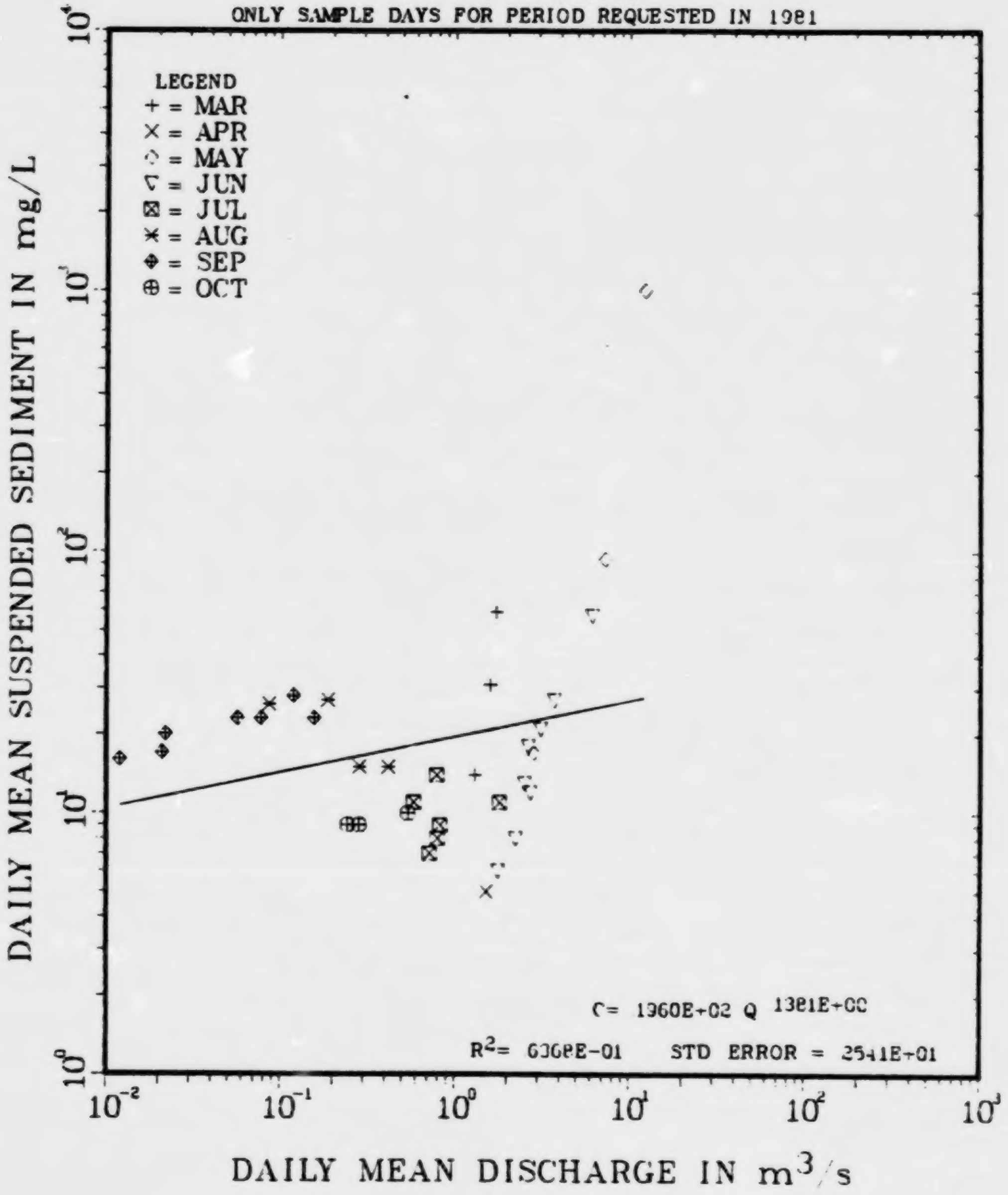
ONLY SAMPLE DAYS FOR PERIOD REQUESTED IN 1976



MILK RIVER AT WESTERN CROSSING OF INTERNATIONAL BOUNDARY

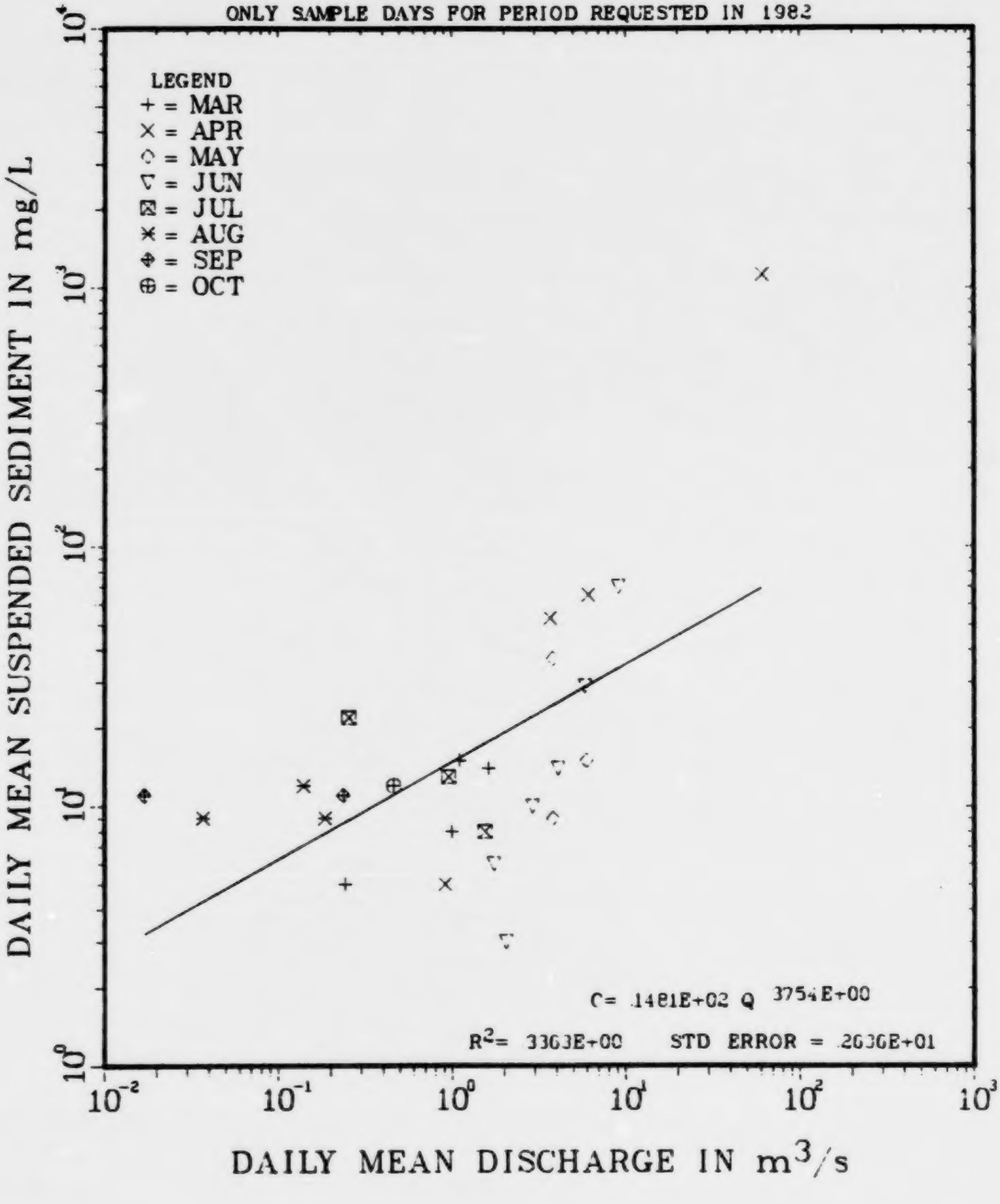
STATION NO. 11AA025

ONLY SAMPLE DAYS FOR PERIOD REQUESTED IN 1981



MILK RIVER AT WESTERN CROSSING OF INTERNATIONAL BOUNDARY

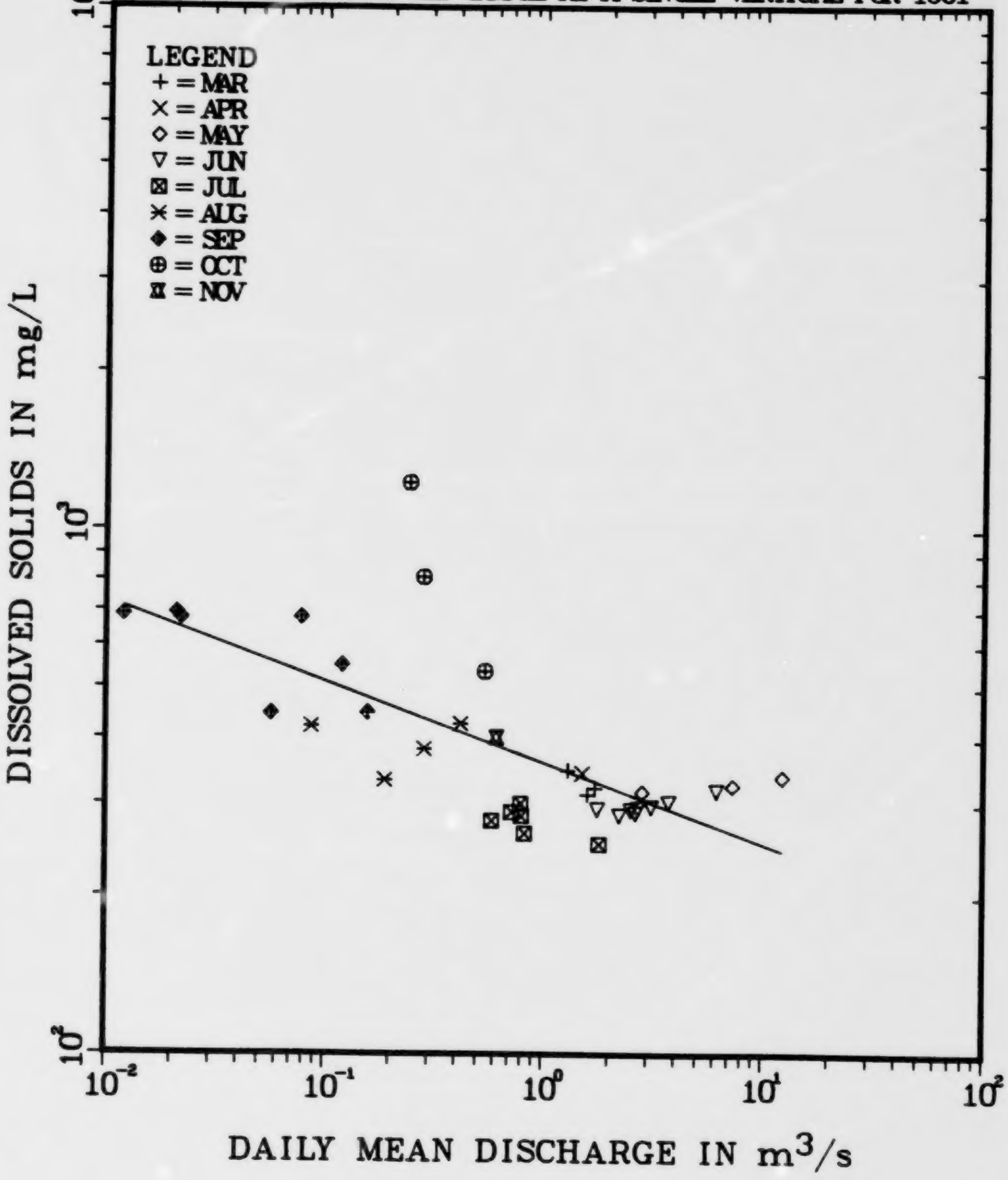
STATION NO. 11AA025
ONLY SAMPLE DAYS FOR PERIOD REQUESTED IN 1982

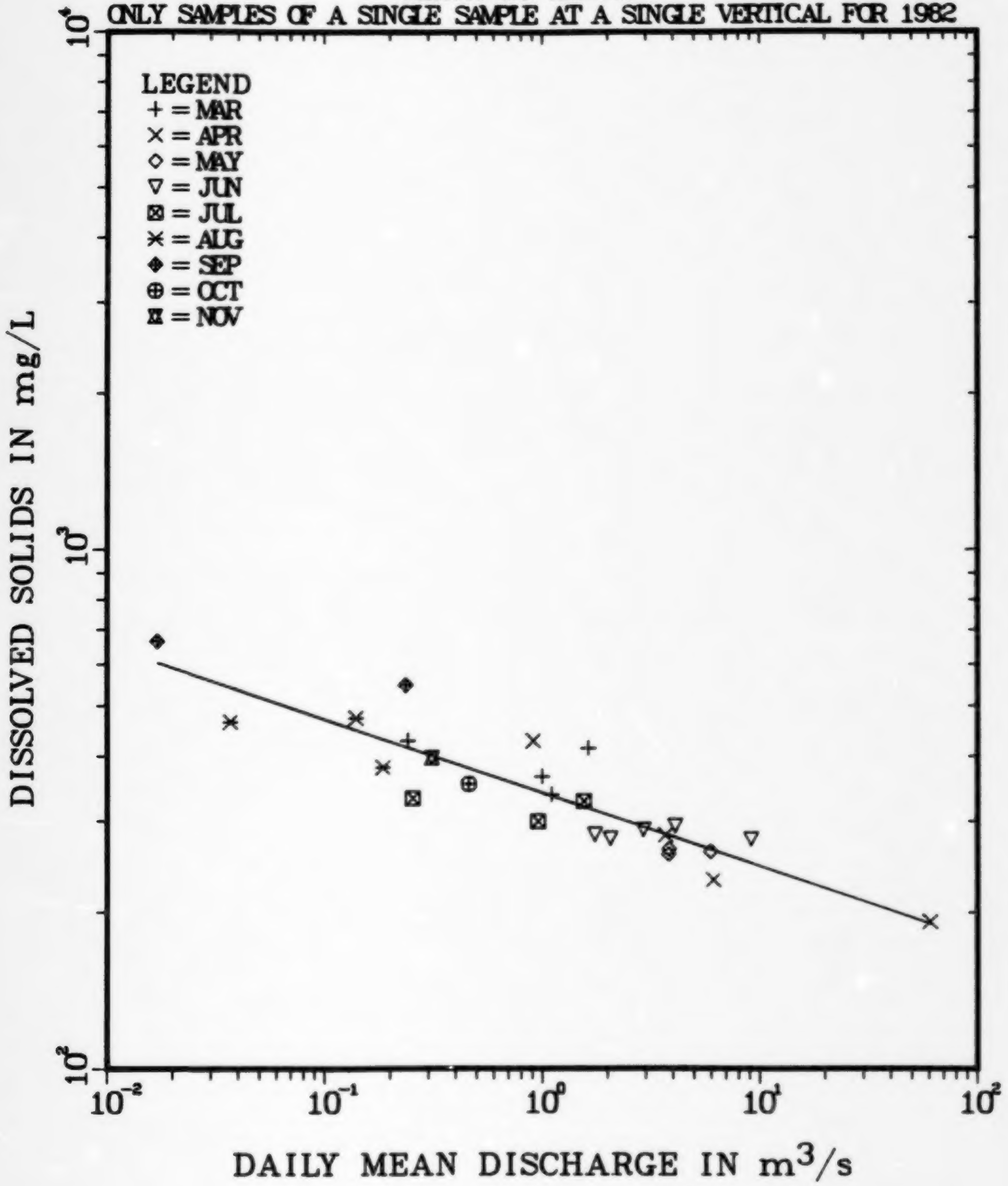


MILK RIVER AT WESTERN CROSSING OF INTERNATIONAL BOUNDARY

STATION NO. 11AA025

ONLY SAMPLES OF A SINGLE SAMPLE AT A SINGLE VERTICAL FOR 1981





MILK RIVER AT WESTERN CROSSING OF INTERNATIONAL BOUNDARY

STATION NO. 11AA025

ONLY SAMPLES OF A SINGLE SAMPLE AT A SINGLE VERTICAL FOR 1982

APPENDIX D

MILK RIVER AT MILK RIVER

11AA005

TABLE OF CONTENTS

MILK RIVER AT MILK RIVER

Page

1.0 HYDROMETRIC STATION DESCRIPTION D-4

1.1 Period of Record D-4
1.2 Gauging Station Description D-4
1.3 Channel and Valley Features D-4
Table D-1: River Valley Flat and Channel Features D-5
1.4 Stereo Pair D-4
Figure D-1: Stereo Pair Aerial Photograph D-6
1.5 On Site Photographs D-6

2.0 HYDRAULIC DATA D-9

2.1 Rating Curve D-9
Figure D-2: Stage-Discharge Relation D-9
2.2 Cross-Section D-9
Figure D-3: Cross-Section at Bridge Crossing D-10
2.3 Specific Gauge Diagram D-11
Figure D-4: Specific Gauge Diagram (1922 to 1986) D-11
2.4 Discharge versus Area; Mean Velocity; Mean Depth D-12
Figure D-5: Discharge versus Cross-Sectional Area D-12
Figure D-6: Discharge versus Mean Velocity D-12
Figure D-7: Discharge versus Mean Depth D-13
Table D-2: Hydraulic Data at Bridge Crossing D-13

3.0 SUSPENDED SEDIMENT DATA D-17

3.1 Period of Sampling and Frequency D-17
Table D-3: Number of Suspended Sediment Samples D-17
3.2 Sampling Location, Procedures and Equipment D-17
3.3 Representativity D-18
Figure D-8: Recurrence Intervals of Total Seasonal Discharge (dam^3) D-18
3.4 Suspended Sediment Discharge Data D-19
Table D-4: Seasonal Suspended Sediment Load D-19
Table D-5: Suspended Sediment Load Simulated by Regression Technique D-20
Table D-9: Suspended Sediment Concentration versus Discharge D-21

4.0 SUSPENDED SEDIMENT PARTICLE SIZE DATA D-22

Table D-6: Particle Size Analysis of Depth-Integrated Suspended Sediment Samples D-22
Figure D-10: Composite Plot for Suspended Sediment Particle Size Distribution D-23

TABLE OF CONTENTS

MILK RIVER AT MILK RIVER

Page

5.0 BED MATERIAL DATA D-22

Figure D-11: Bed Material Data D-24

6.0 BED LOAD DISCHARGE DATA D-24

7.0 DISSOLVED SOLIDS DATA D-24

DIAGRAMS AND TABLES OF DATA D-25

- Station Description D-25
- Flow Duration Curve D-26
- Streamflow and Sediment Hydrographs D-27
- Instantaneous Suspended Sediment and Dissolved Solids Data .. D-30
- Published Sediment Data D-36
- Annual Suspended Sediment Rating Curves D-40
- Dissolved Solids versus Discharge Plots D-46

MILK RIVER AT MILK RIVER: 11AA005

1.0 HYDROMETRIC STATION DESCRIPTION

1.1 PERIOD OF RECORD

This gauging station was established on May 18, 1909 and with minor relocations (within 500 metres of the present location) operated continuously up to the present time.

1.2 GAUGING STATION DESCRIPTION

The present gauging station is located on the right bank, immediately below the bridge crossing of Highway No. 4.

The station consists of a 1.5 metre wood stave culvert stilling well, linked to the stream by two metal pipe intakes. The well is covered by a standard metal walk-in shelter, which houses a float operated A-71 Stevens strip chart recorder. In addition, the shelter houses a telemark linked to the recorder, which provides water level information on demand.

High flow (>12 m^3/s) streamflow discharge measurements are made from the downstream rail of the highway bridge, while wading measurements for lower flows are made by wading in the vicinity of the gauge. Prior to 1973, streamflow measurements were taken from a cableway which spanned the river 20 metres above the highway bridge.

A copy of the fieldman's station description can be found on page D-25.

1.3 CHANNEL AND VALLEY FEATURES

The significant features of the valley and river in the vicinity of the gauge are detailed in Table D-1, the data for which were extracted from aerial photographs and from personal knowledge of the site. The classification and interpretation is based on an abbreviated form of that developed by Kellerhals et al, (1976).

1.4 STEREO PAIR

Figure D-1 is a stereo pair of the gauging station site. The photos were taken in October 1979 and have a scale of 1:24 000.

TABLE D-1

MILK RIVER AT MILK RIVER

RIVER VALLEY, VALLEY FLAT AND CHANNEL FEATURES

GENERAL DESCRIPTION IN VINCITY OF HYDROMETRIC STATION (ABOVE VALLEY)

Terrain : Plains
Vegetation : Grass
Land Use : Mainly Cultivated, Partly Urbanized

VALLEY CHARACTERISTICS ABOVE VALLEY FLAT

Slumping of Valley Walls : None
Vegetation on Valley Walls : Grass

TERRACES

Presence : Continuous
Number of Levels : Several

RELATION OF CHANNEL TO VALLEY

Valley Type : Not Applicable, On Alluvial Plain
Relation of Channel to Valley Bottom: Not Applicable
Relation of Channel to Valley Walls of Resistant Terraces : Frequently Confined

DESCRIPTION OF VALLEY FLAT

Presence : Continuous
Extent : Moderate (1 to 5 stream widths)
Vegetation : Grass and Shrubs
Land Use : Partly Cultivated

CHANNEL DESCRIPTION

Pattern : Irregular
Islands : Very Infrequent
Bar Type : Point and Side Bars
Type of Flow : Uniform With Rapids in Reach

LATERAL CHANNEL ACTIVITY

Lateral Activity : Progression and Cut-offs
Lateral Stability : Slightly Unstable

CHANNEL BANK AND BEDS

Alluvial Bank Material : Silt and Sand
Bank Vegetation : Grass and Shrubs
Predominant Bed Material : Sand and Gravel

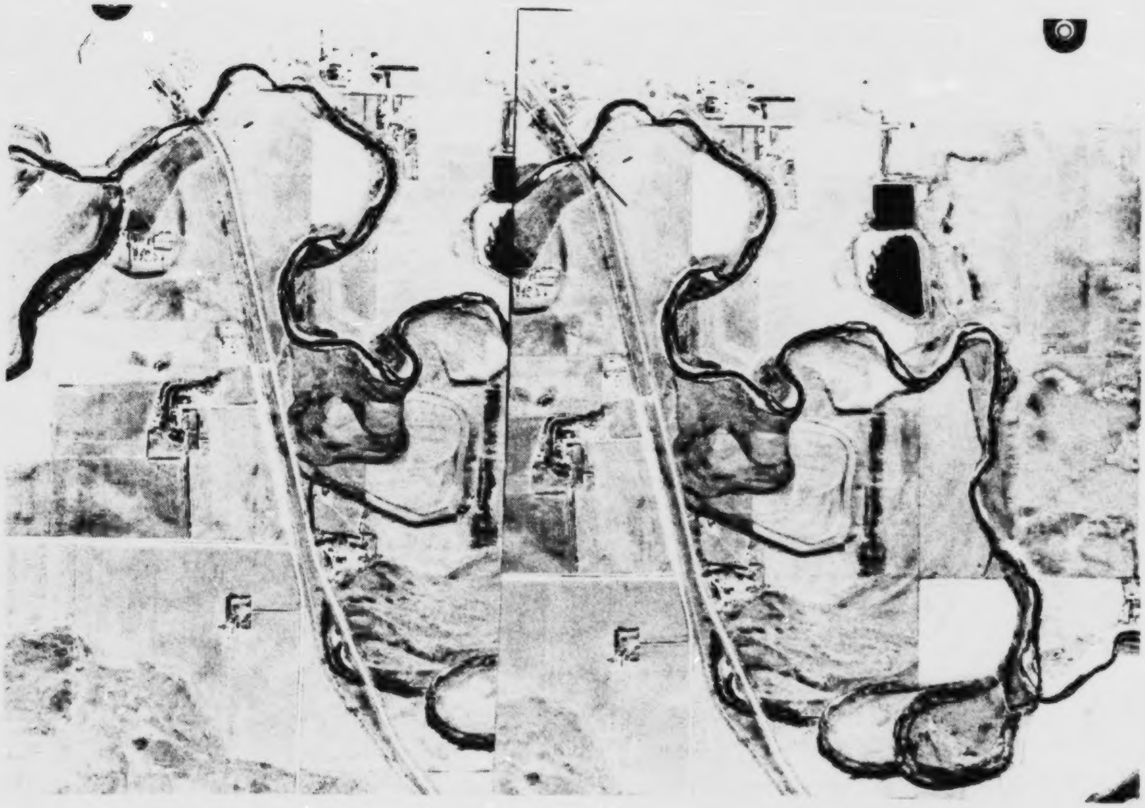
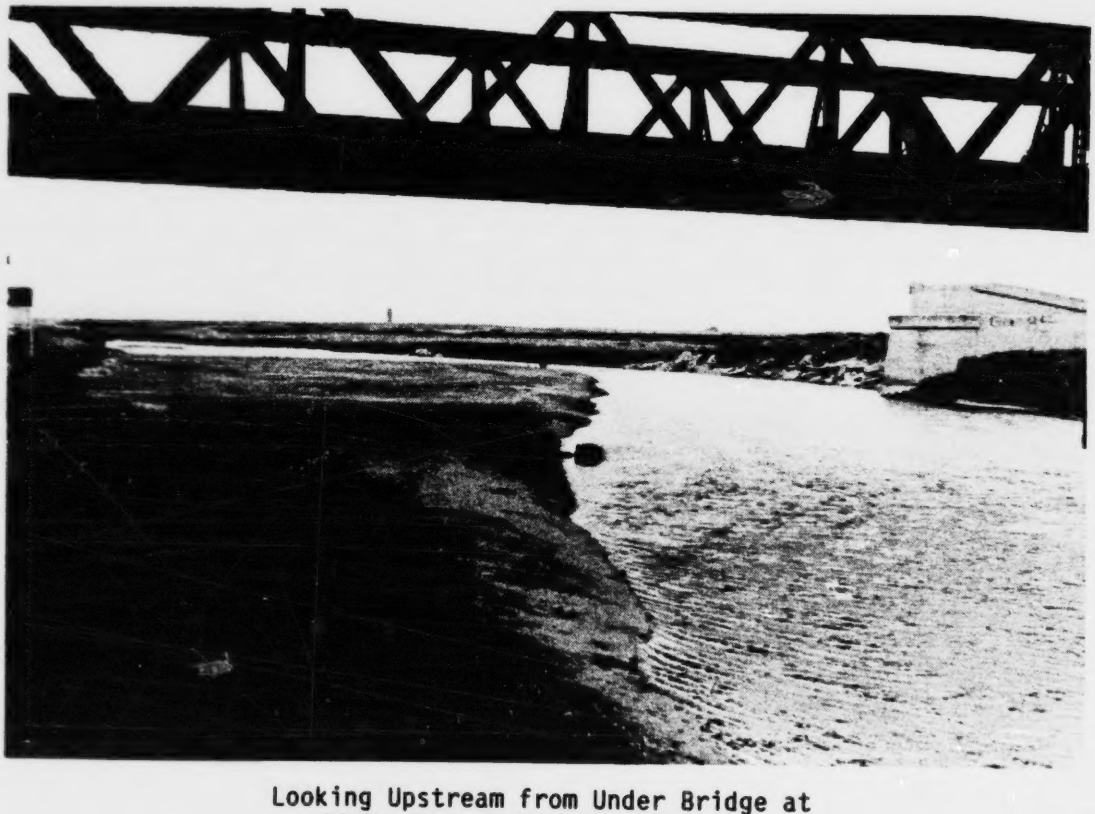


Figure D-1

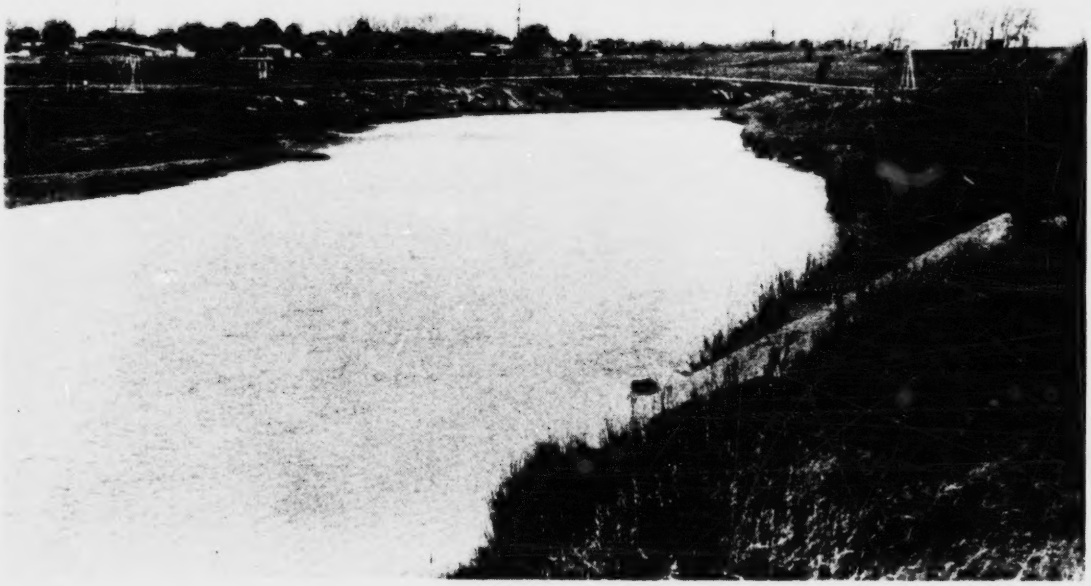
Stereo Pair Aerial Photographs
Arrow Indicates Station: Town of Milk River at Top of Photos
Milk River at Milk River

1.5 ON SITE PHOTOGRAPHS

Looking Upstream at Gauge and Bridge Crossing



Looking Upstream from Under Bridge at
Right Bank Side Bar from where
Bed Material Samples were Taken



Looking Downstream
from Gauge

Lookng Upstream
at Side Bar Bed
Material Sampling
Locations.

2.0 HYDRAULIC DATA

2.1 RATING CURVE

The stage-discharge relations since 1975 are reproduced in Figure D-2. From this diagram, it is evident that the curve is moderately unstable, which can be attributed to sand dune movement through the cross-section. Note that Curve No. 10, used for the period June 1975 to March 1976, was for the previous gauge location, which was located 500 metres below the bridge on the left bank. This curve was only included to show the relative ratings between the two sites.

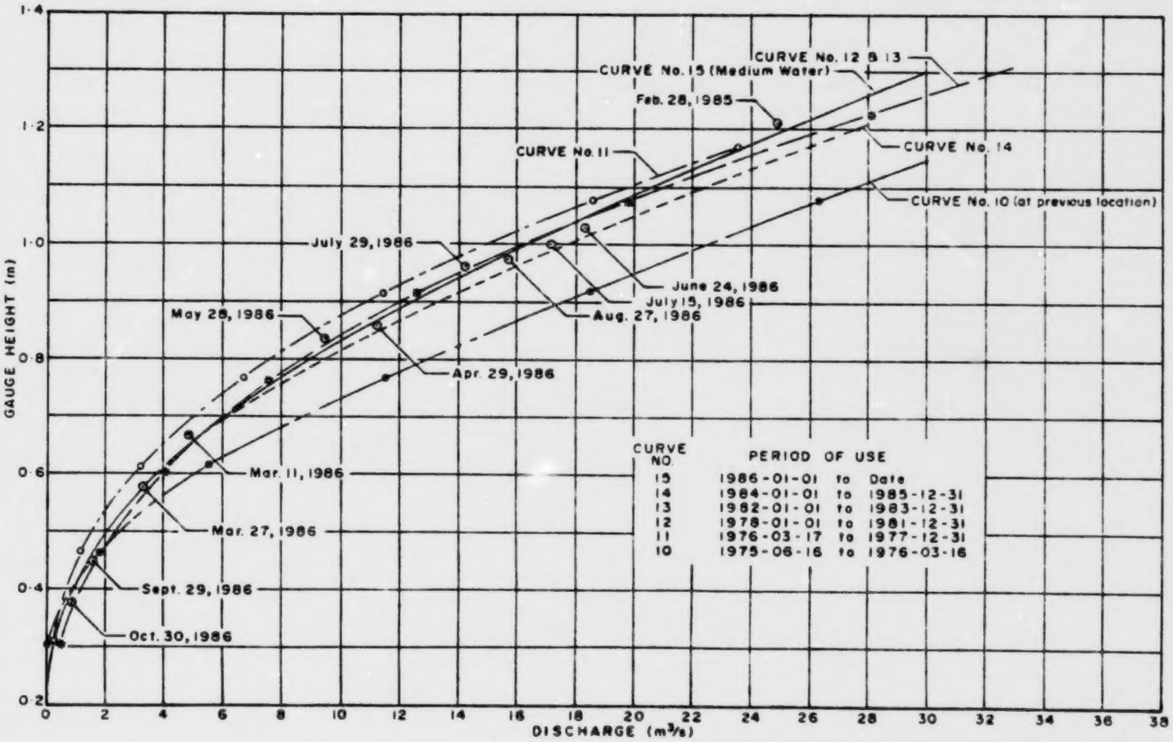


Figure D-2

Stage-Discharge Relation, 1975 to Date
Milk River at Milk River

2.2 CROSS-SECTIONS

The cross-sections depicted in Figure D-3 were derived from streamflow discharge measurements taken from the downstream side of the highway bridge crossing. These cross-sections are not truly representative of the natural stream, as the section used is confined by the

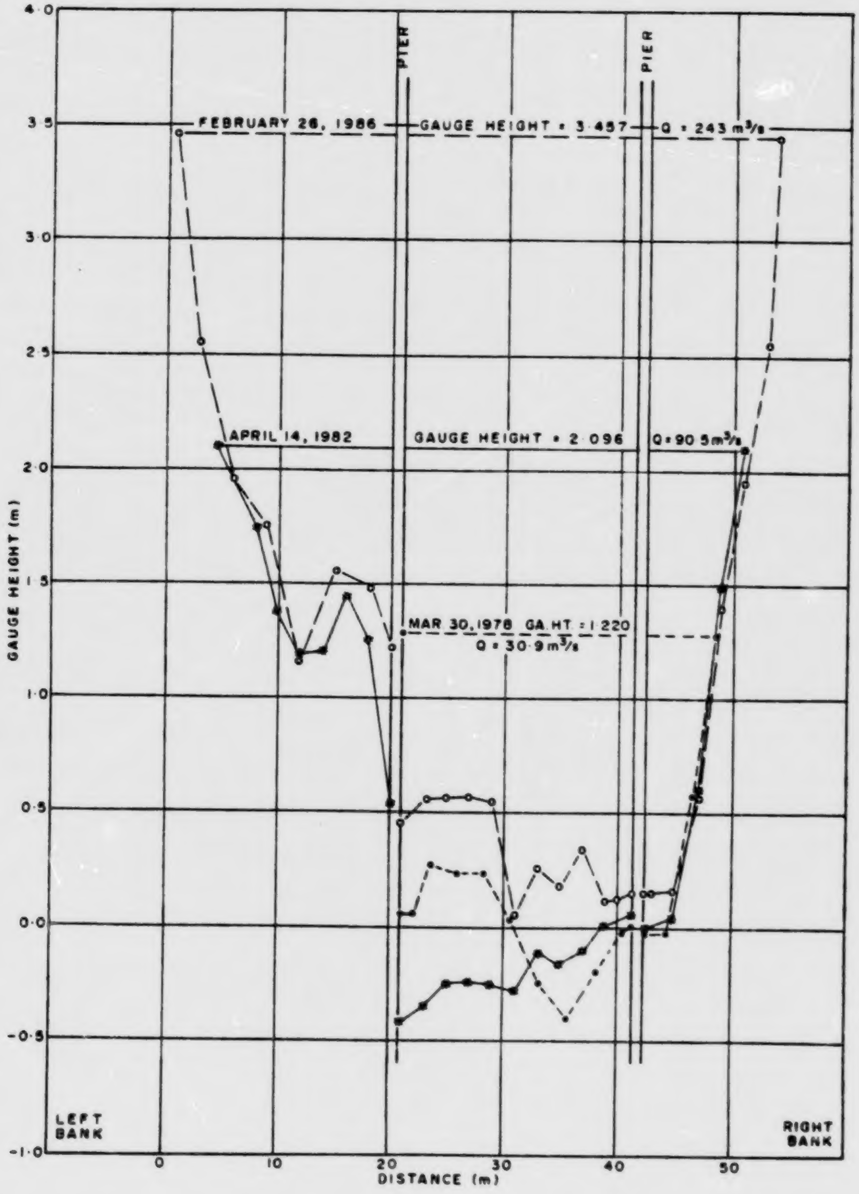


Figure D-3

Cross-Sections at Highway No. 4 Crossing
Milk River at Milk River

bridge crossing with trimmed and riprapped slopes, and by bridge piers. Nonetheless, the plots do indicate the movement of dunes through the section, which undoubtedly is the reason for the stage-discharge curve instability.

Three measurements were selected for cross-section reproductions; March 30, 1978, April 14, 1982 and February 26, 1986. These plots indicate changes in the cross-section from 0.5 to 0.8 metres between the two bridge piers over the 9 years.

2.3 SPECIFIC GAUGE DIAGRAM

Figure D-4 is a specific gauge plot for the period of record from 1922 to 1986. This diagram shows the gauge heights at three different discharges (2, 10, 20 m^3/s) for the period of record.

It is evident from this plot that no significant aggradation or degradation has occurred over the past 65 years. It should be noted that the gauge was moved at the end of 1976 and its effect on the plot is readily discernible; that is, the low water control remained relatively unchanged (the rapids located below the old gauge site), whereas, the high water portion of the relation has changed significantly (channel control segment moved upstream).

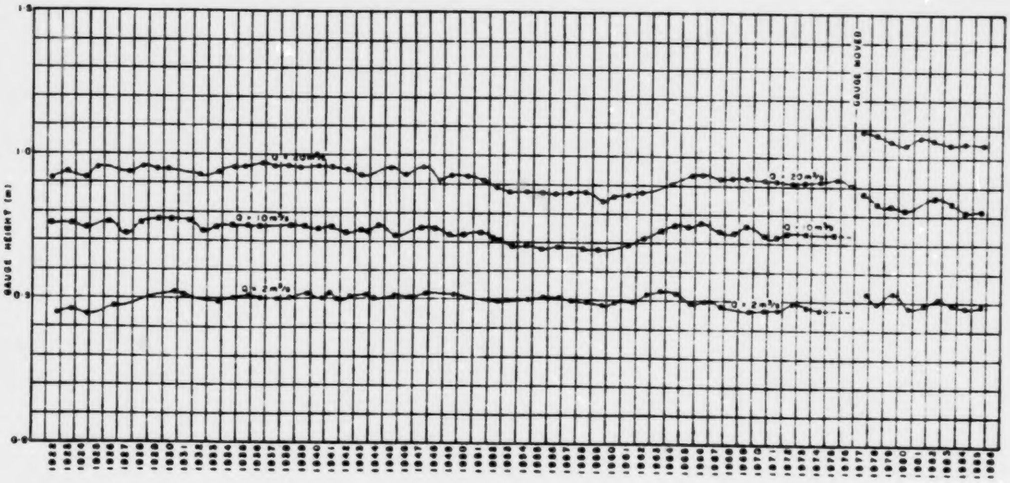


Figure D-4

Specific Gauge Diagram: 1922 to 1986
Milk River at Milk River

2.4 DISCHARGE VERSUS AREA; MEAN VELOCITY; MEAN DEPTH

Plots of discharge versus cross-sectional area, discharge versus the mean velocity in the cross-section, and discharge versus the mean depth of the cross-section are reproduced in figures D-5 to D-7. The cross-section in question is that at the highway crossing and data were derived from streamflow discharge measurements taken at this location. The data from these measurements are tabulated in Table D-2.

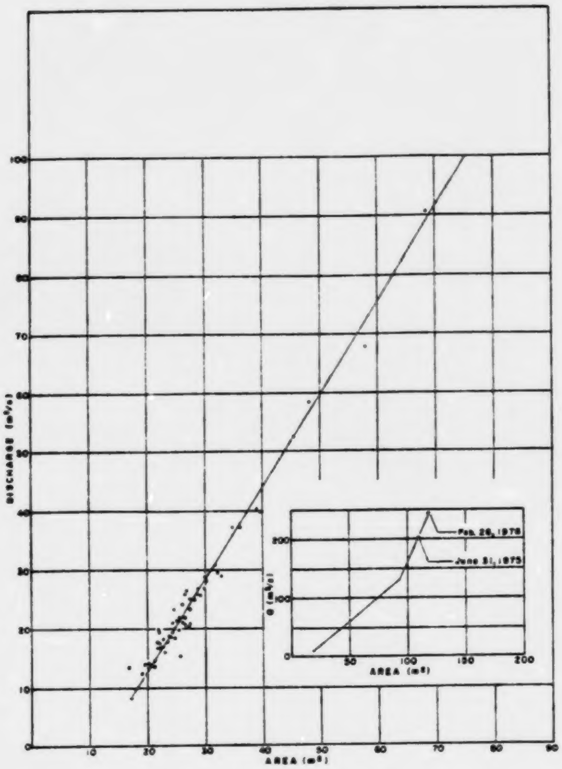


Figure D-5

Discharge Versus Cross-Sectional Area

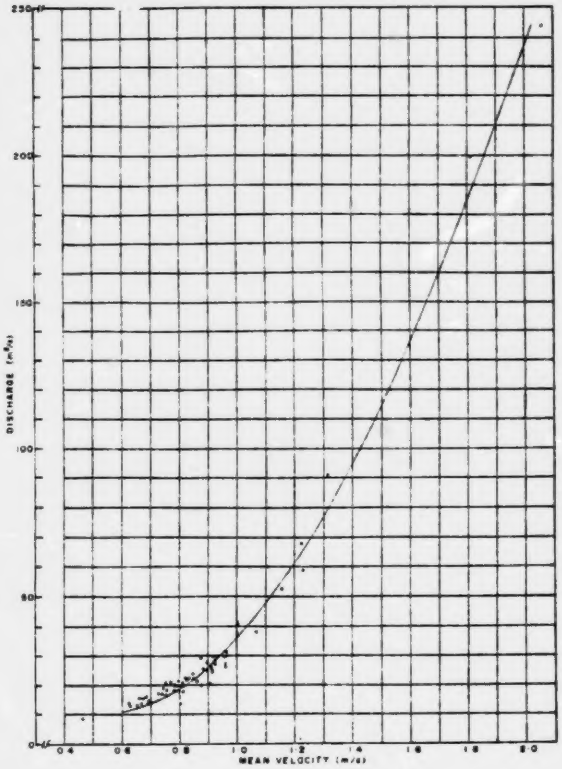


Figure D-6

Discharge versus Mean Velocity

Milk River at Milk River

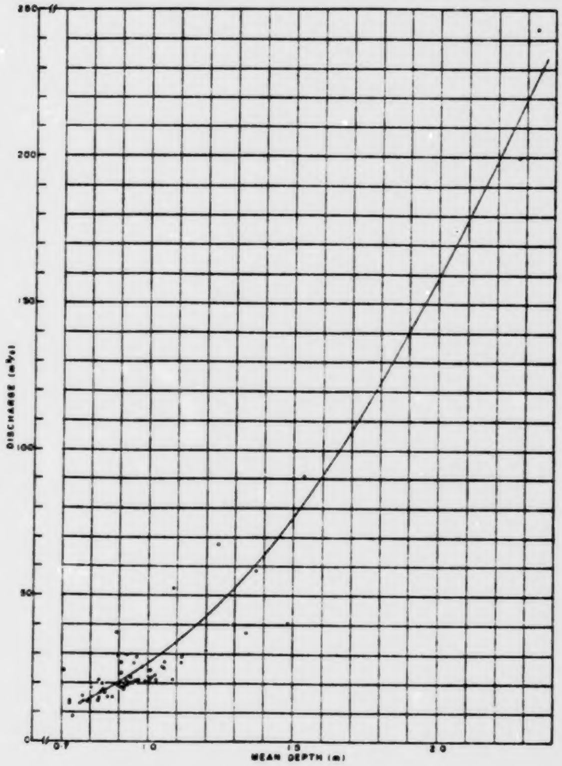


Figure D-7

Discharge Versus Mean Depth
Milk River at Milk River

TABLE D-2

MILK RIVER AT MILK RIVER

HYDRAULIC DATA AT BRIDGE SECTION

Date	Discharge	Gauge Height (m)	Mean Velocity (m/s)	Area (m^2)	Width (m)	Mean Depth (m)
1985						
Apr. 3	23.3	1.132	0.971	24.0	26.5	0.91
1984						
June 16	19.9	1.045	0.913	21.8	26.0	0.84

TABLE D-2 (cont'd.)

Date	Discharge	Gauge Height (m)	Mean Velocity (m/s)	Area (m^2)	Width (m)	Mean Depth (m)
1983						
June 15	16.7	1.008	0.759	22.0	26.2	0.84
July 12	19.2	1.029	0.877	21.9	26.0	0.84
Aug. 18	17.7	1.011	0.819	21.6	25.3	0.85
1982						
Apr. 14	90.5	2.096	1.32	68.7	44.5	1.54
Apr. 15	58.4	1.661	1.23	47.6	34.5	1.38
Apr. 27	12.3	0.902	0.624	19.7	25.6	0.77
May 20	25.6	1.167	0.966	26.5	27.1	0.98
June 3	21.5	1.111	0.860	25.0	26.5	0.94
June 14	16.7	0.989	0.746	22.4	26.1	0.86
July 13	18.7	1.080	0.786	23.8	26.5	0.90
1981						
Mar. 24	16.5	0.982	0.757	21.8	25.5	0.85
May 28	28.9	1.201	0.963	30.0	31.1	0.96
June 10	22.1	1.122	0.844	26.2	25.5	1.03
June 18	24.9	1.155	0.899	27.7	26.5	1.05
June 23	21.8	1.096	0.855	25.5	27.0	0.94
July 8	19.8	1.056	0.783	25.3	27.0	0.94
July 14	19.7	1.065	0.791	24.9	29.5	0.84
July 15	20.2	1.067	0.811	24.9	25.9	0.96
July 20	19.9	1.066	0.796	25.0	27.0	0.93
Aug. 19	18.1	1.005	0.790	22.9	25.3	0.91
Sept.14	16.7	1.975	0.729	22.9	25.0	0.92
1980						
Apr. 10	17.5	0.996	0.788	22.2	26.0	0.85
Apr. 16	37.1	1.384	1.07	34.8	39.0	0.89
Apr 29	24.0	1.146	0.920	26.1	37.0	0.72
June 17	25.0	1.151	0.912	27.4	26.0	1.05
July 18	19.9	1.039	0.802	24.8	25.6	0.77
Aug. 14	18.9	1.032	0.794	23.8	25.5	0.73

TABLE D-2 (cont'd.)

Date	Discharge	Gauge Height (m)	Mean Velocity (m/s)	Area (m^2)	Width (m)	Mean Depth (m)
1979						
Apr. 19	28.9	1.222	0.875	33.0	36.9	0.89
May 15	14.3	0.939	0.677	21.1	25.3	0.83
June 13	21.9	1.091	0.832	26.3	25.9	1.02
July 17	18.6	1.039	0.783	23.7	25.9	0.92
Aug. 14	17.7	1.003	0.756	23.4	25.9	0.90
1978						
Mar. 23	40.2	1.417	1.030	39.0	26.2	1.49
Mar. 29	39.9	1.417	1.006	39.7	30.5	1.30
Mar. 30	30.9	1.280	0.966	32.0	26.5	1.21
July 12	19.2	1.058	0.789	24.3	25.6	0.95
1977						
May 18	21.7	1.134	0.829	26.1	25.6	1.02
June 13	20.4	1.091	0.759	27.3	27.4	1.00
1976						
Mar. 30	8.0	0.725	0.460	17.4	23.5	0.74
Apr. 12	15.0	0.908	0.661	22.7	25.9	0.88
Apr. 27	13.6	0.869	0.668	20.3	25.9	0.78
May 11	26.6	1.052	0.924	28.8	27.1	1.06
June 16	28.1	1.055	0.927	30.3	27.1	1.12
July 13	23.3	0.966	0.850	27.4	27.1	1.01
Aug. 18	21.8	0.957	0.823	26.5	26.5	1.00
Sept.16	20.3	0.899	0.756	26.8	27.4	1.09
1975						
Apr. 29	37.1	1.231	1.024	36.2	27.1	1.34
May 13	52.4	1.353	1.158	45.2	41.5	1.09
May 27	13.3	0.780	0.628	21.1	25.3	0.83
June 16	15.5	0.847	0.680	22.9	29.3	0.78
June 21	199.	2.752	1.811	110.	48.2	2.28
June 22	67.7	1.661	1.225	55.2	44.5	1.24
June 24	26.9	1.088	0.899	29.9	26.8	1.12
Sept.19	20.7	0.933	0.756	27.4	27.1	1.01

TABLE D-2 (cont'd.)

Date	Discharge	Gauge Height (m)	Mean Velocity (m/s)	Area (m^2)	Width (m)	Mean Depth (m)
1974						
Apr. 2	13.4	0.802	0.802	16.7	21.3	0.73
Apr. 8	13.6	0.802	0.692	19.7	25.0	0.79
Apr. 19	26.2	1.018	0.978	26.8	29.3	0.91
May 8	29.4	1.085	0.917	32.1	34.7	0.93
May 13	26.3	1.027	0.911	28.9	30.5	0.95
June 5	20.5	0.933	0.771	26.6	27.4	0.97
July 15	20.8	0.930	0.802	26.0	25.3	1.03
Aug. 12	18.4	0.893	0.744	24.7	27.1	0.91
1973						
May 14	13.8	0.811	0.692	20.1	27.4	0.73
May 20	21.0	0.933	0.866	24.2	29.0	0.83
July 16	18.0	0.884	0.796	22.7	28.3	0.80
Aug. 27	12.4	0.789	0.652	19.0	25.9	0.73
1986						
Feb. 26	243.	3.457	2.06	118.	50.5	2.34
Feb. 28	24.9	1.210	0.889	28.0	26.5	1.06

3.0 SUSPENDED SEDIMENT DATA

3.1 PERIOD OF SAMPLING AND FREQUENCY

A suspended sediment sampling program was conducted from 1974 to 1976 and from 1981 to date. During two of these years, 1981 and 1982, sufficient samples were collected by the field technician and by a hired observer to adequately define a continuous concentration time graph and thus, daily suspended sediment discharges were computed for these years.

TABLE D-3

MILK RIVER AT MILK RIVER

NUMBER OF SUSPENDED SEDIMENT SAMPLES

YEAR	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	TOTAL
1974	-	-	2	1	1	1	2	1	8
1975	2	5	2	4	1	1	1	2	18
1976	1	2	1	1	1	1	1	1	9
1981	3	1	3	8	6	4	7	4*	36
1982	3	5	4	8	6	4	2	3*	35
1983	2	1	2	1	1	1	1	1	10
1984	2	2	1	1	-	2	-	1	9
1985	1	2	1	1	2	1	-	2*	10
1986	2	2	1	1	2	1	1	1	11

* - One of these samples were taken in November.

3.2 SAMPLING LOCATION, PROCEDURES AND EQUIPMENT

During high flow periods (>15 m^3/s) depth-integrated suspended sediment samples were taken from the highway bridge, utilizing a DH-59 sampler. During lower flow periods, samples were taken by wading, utilizing a DH-48 sampler. No fixed point was set for the sample location, but rather samples were taken near mid-stream.

Eight suspended sediment discharge measurements were made in 1981 and six were made in 1982. A suspended sediment discharge measurement involves the taking of depth-integrated samples at the 20% equal flow value points across the stream. The average of the concentrations taken at the five verticals is compared to the daily samples taken and the appropriate correction factor (K) is calculated. The K-factor in 1981 varied from unity to 0.57 and that in 1982 varied from 0.85 to 1.07. Reasons for the variations were not ascertained.

3.3 REPRESENTATIVITY

With only two years of sediment suspended sediment discharge data available and 8 additional years of miscellaneous sample data availability, it is unlikely that the sampling program conducted to date is sufficient to adequately and accurately define the suspended sediment regime at Milk River at Milk River. Nonetheless, samples have been taken over a wide range of flows from very low values up to

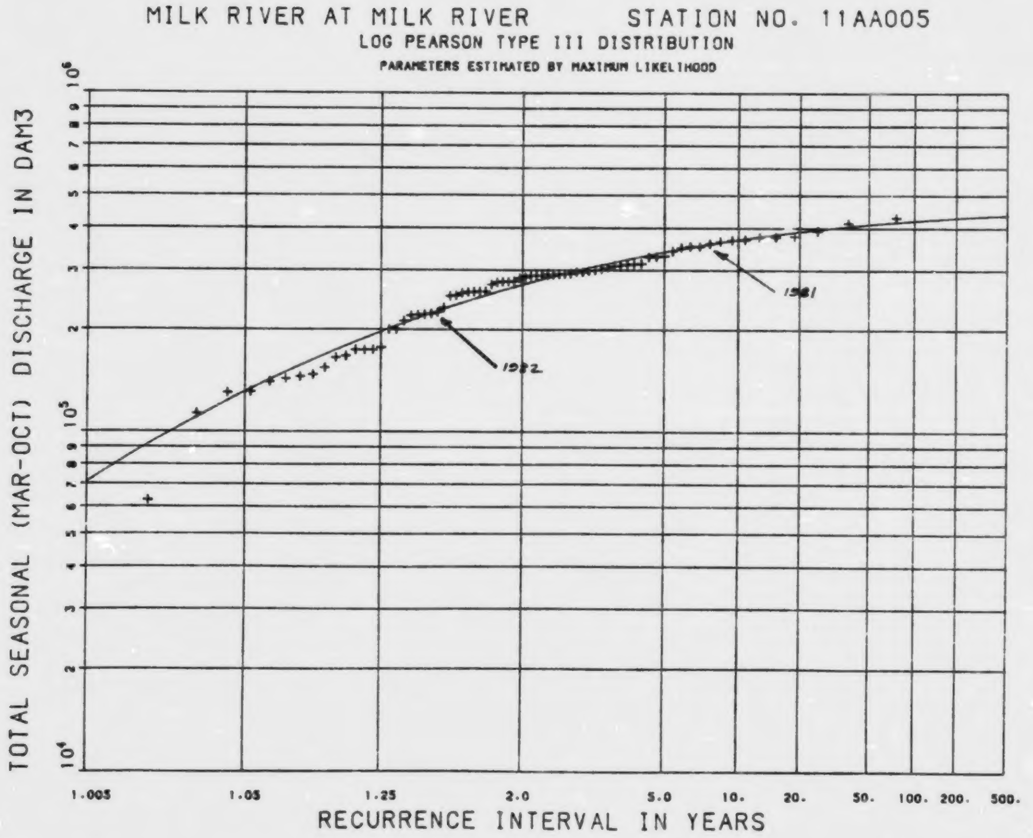


Figure D-8

Recurrence Intervals of Total Seasonal Discharge (dam^3)

a maximum of 199 m^3/s, as compared to a maximum recorded streamflow discharge of 240 m^3/s recorded in June of 1975. Thus, the sediment rating curves do cover the range of flows adequately, but a great deal of caution must be used in applying sediment rating curves.

Figure D-8 is a recurrence interval plot of total seasonal (March to October) streamflow for the period of record. The two years for which computed suspended sediment discharge are available are indicated on this plot to provide a visual indication of coverage.

3.4 SUSPENDED SEDIMENT DISCHARGE DATA

Two years of actual suspended sediment discharge data are available for the March to October period and this is contained in Table D-4. Suspended sediment loads for 1960 to 1985 have been simulated, utilizing a sediment rating curve developed from all the instantaneous sediment data collected and the respective flow data. The procedure is described in Ashmore (1980). The fabricated data is contained in Table D-5, but it should be noted that the exp. $2.65s^2$ correction factor has not been applied (Ashmore 1980).

Table D-4 also contains a comparison of computed and fabricated seasonal suspended sediment discharges, but with only two years of data available, it is difficult to make any judgements on the accuracy of the simulated data.

TABLE D-4

MILK RIVER AT MILK RIVER

SEASONAL SUSPENDED SEDIMENT LOAD

YEAR	SEASON	SUSPENDED SEDIMENT LOAD COMPUTED BY NORMAL PROCEDURES (TONNES)	SUSPENDED SEDIMENT LOAD SIMULATED BY REGRESSION TECHNIQUES (TONNES)	SIMULATED AS PERCENT OF COMPUTED
1981	Mar. to Oct.	90 500	100 700	+11.3
1982	Mar. to Oct.	129 000	91 700	-28.9

Using the flow duration curve found on page D-26 and the suspended sediment discharge rating curve, the mean seasonal load for 1960 to 1985 was computed as 111 000 tonnes, whereas, the mean seasonal load as found in Table D-5 was 81 000. This is a significant difference and further points out the need for extreme caution when utilizing data from rating curves.

TABLE D-5

SUSPENDED SEDIMENT LOAD SIMULATED BY REGRESSION TECHNIQUE

WATER SURVEY OF CANADA MILK RIVER AT MILK RIVER STATION NO. 11AA005
11/03/87 . PAGE 1
SEDIMENT SURVEY SECTION

TOTAL LOADS IN TONNES

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1960			26935	1435	15904	12718	9978	9786	5899	13			82669
1961			466	6887	10580	13144	10625	9665	6579	216			58162
1962			3695	14015	13717	12560	9890	8997	256	8			63138
1963			145	9465	10399	14122	11634	9707	6211	3			61686
1964			63	6831	32140	54999	5400	11448	10077	117			121075
1965			779	39003	4166	31568	10991	12819	7589	157			107071
1966			6375	2733	13282	30786	13380	13326	9340	106			89328
1967			6932	6071	62974	14240	15088	12658	10494	76			128533
1968			2487	9072	20189	20916	13860	12523	10220	443			89710
1969			7060	52538	8555	23968	17589	11866	5467	106			127149
1970			168	5818	13843	17911	12089	11725	5594	49			67296
1971			651	6518	10378	4792	12307	10344	10358	2256			57605
1972			73547	4410	26989	18847	15304	13532	11200	3002			166831
1973			573	659	7575	11460	10274	7759	13	2			38314
1974			1440	14044	22627	11330	12735	10138	6890	22			79227
1975			15	3486	33394	86683	5847	13030	10585	369			153408
1976			3498	3965	18363	20028	15612	15513	11534	1771			90284
1977			20	963	8628	10502	1213	713	338	11			22387
1978			28927	2240	1855	6865	9952	9433	5949	84			55304
1979			19080	7584	7084	14102	10293	8628	2022	11			69804
1980			489	13562	16991	17132	12147	10471	3336	39			74166
1981			6333	5572	25262	18492	11753	9334	7800	84			84631
1982			738	40237	14150	11718	10158	21	7	24			77053
1983			2703	4308	2644	8063	10538	8992	115	2			37365
1984			2651	1994	3370	9945	8542	6312	3	1			33817
1985			1050	12776	12445	12559	5901	8783	6689	158			60361
MEAN			7570	10600	18100	19600	10900	9940	5840	351			81000
DEV			15600	13100	12800	17000	3530	3480	4010	762			35600

NOTE: To use the values in Table D-5, increase by a factor of exp. $2.65s^2$, but extreme caution should be exercised in their use.

It should also be immediately evident when viewing the plots of concentration versus discharge, that sediment discharge decreases with time even though the discharge remains relatively the same, undoubtedly attributable to a reduction in available particles from the stream bed and bank; another reason for using the sediment rating curve with extreme caution.

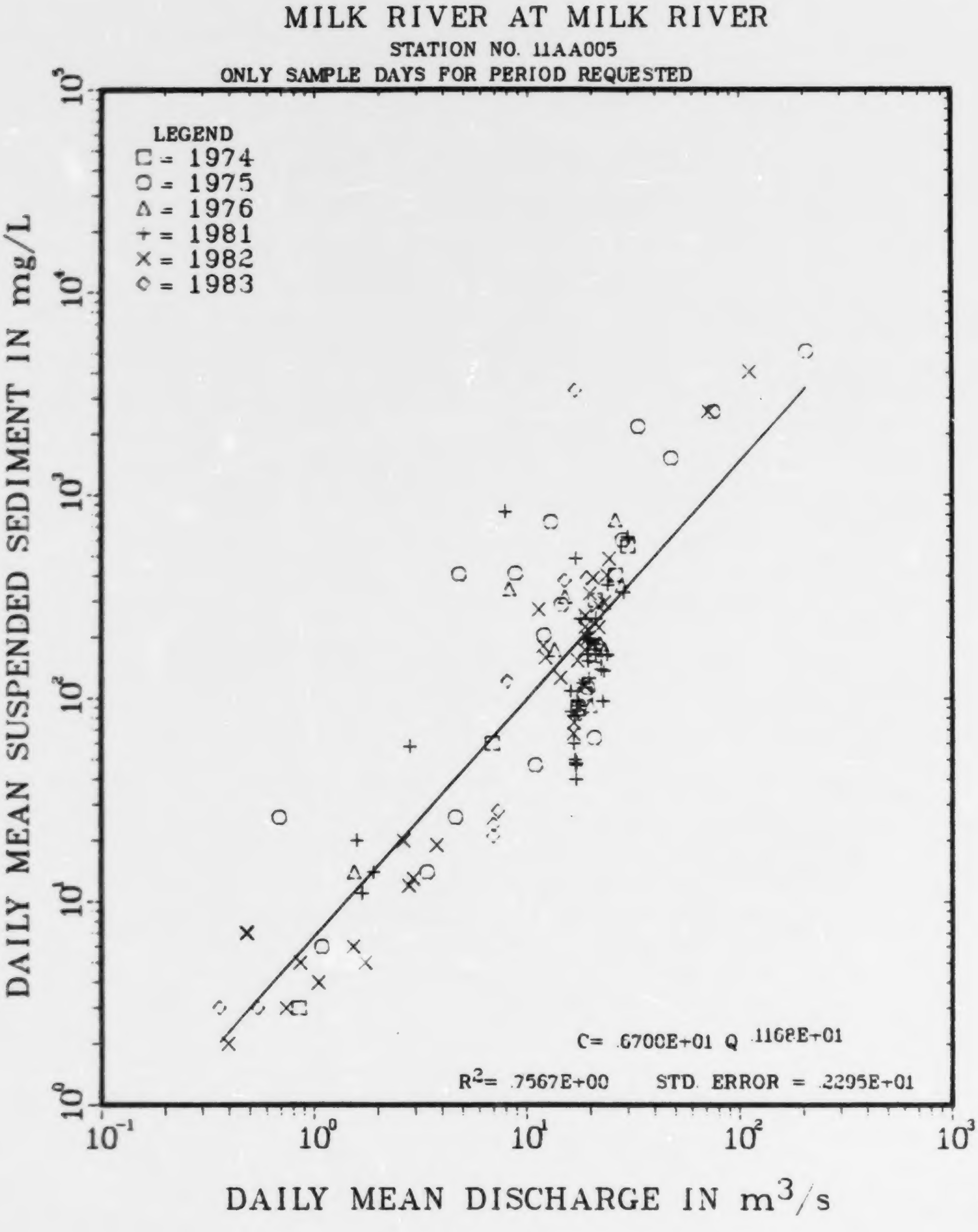


Figure D-9

Suspended Sediment Concentrations versus Discharge

4.0 SUSPENDED SEDIMENT PARTICLE SIZE DATA

Only four suspended sediment samples have been analyzed for particle size information and the data for these can be found in Table D-6. The composite plot of these data is depicted in Figure D-10.

TABLE D-6

PARTICLE SIZE ANALYSIS OF DEPTH-INTEGRATED SUSPENDED SEDIMENT SAMPLES

WATER SURVEY OF CANADA
09/09/85 , PAGE 1
SEDIMENT SURVEY SECTION

MILK RIVER AT MILK RIVER

STATION NO. 11AA005

DEPTH INTEGRATING PARTICLE SIZE ANALYSIS OF SUSPENDED SEDIMENT

SAMPLE IDENTIFIER DATE	TIME	DISCHARGE (M3/S)	CONC. (MG/L)	PERCENT FINER THAN INDICATED SIZE, IN MICROMETRES 2	4	8	16	31	62	125	250	500	1000	2000	TOTAL D50	GDG	SAND D50	GDG	PERCENT CLAY	SILT	SAND
MAR 11 1981	1200	7.92	801 R	09	21	33	48	65	79	91	97	99	99		17.3	5.2	119.8	1.7	21	58	21
MAR 24 1981	1230	16.5	478 R	13	18	27	38	50	65	81	92	95	97		31.0	6.7	134.4	2.1	18	47	35
MAY 21 1981	0920	29.9 H	801 R	09	16	24	32	41	56	78	94	98	99		49.0	6.2	129.0	1.7	16	40	44
APR 14 1982	1640	90.5	4 320 R	09	16	24	34	48	68	86	97	99	100		33.5	9.3	113.4	1.7	16	52	32

DISCHARGE FOOTNOTE SYMBOLS
BLANK - INSTANTANEOUS
H - DAILY MEAN

CONCENTRATION FOOTNOTE SYMBOLS
R - SAMPLES COLLECTED IN SEVERAL VERTICALS

GDG (GRADING) = SQUARE ROOT (D84/D16)

5.0 BED MATERIAL DATA

Two bed material samples were taken on October 1, 1985. One was a surface sample taken on a side bar on the right bank above the highway bridge crossing. This sample was taken utilizing a transect sampling procedure (Yuzyk, 1986). The second sample was a bulk sub-surface sample taken from the same side bar (Yuzyk, 1986). Figure D-11 contains the analyzed data for these samples.

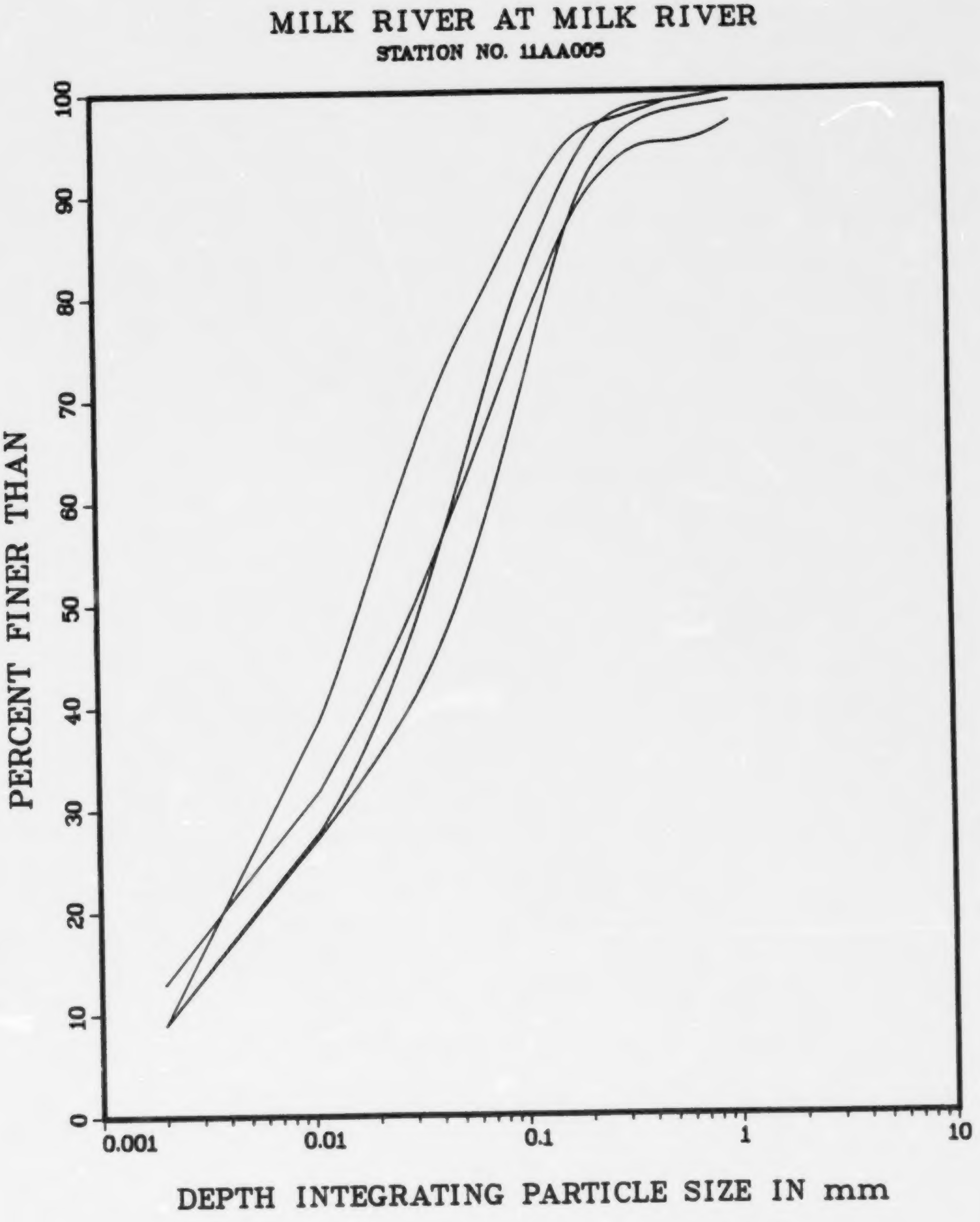


Figure D-10

Composite Plot for Suspended Sediment Particle Size Distribution

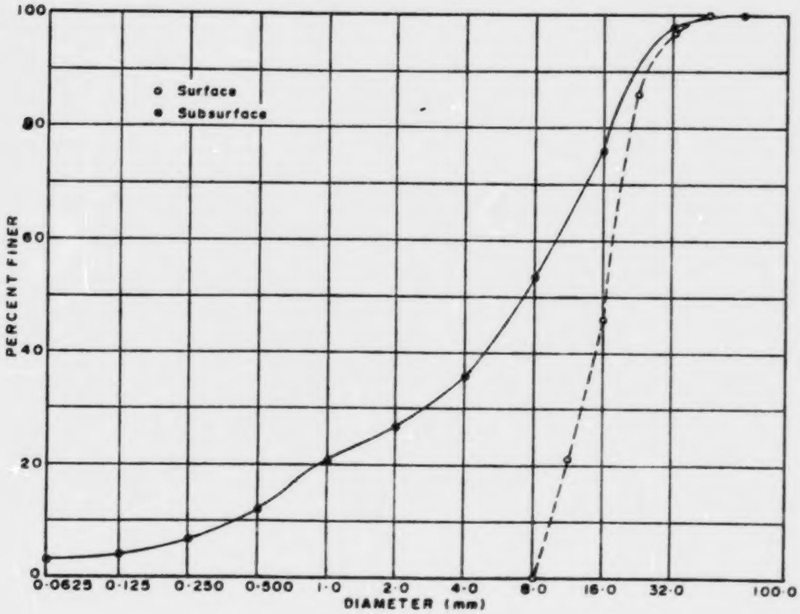


Figure D-11

Bed Material Data
Milk River at Milk River

Photos D-7 and D-8 show the bed material sampling location.

6.0 BED LOAD DISCHARGE DATA

No data available.

7.0 DISSOLVED SOLIDS DATA

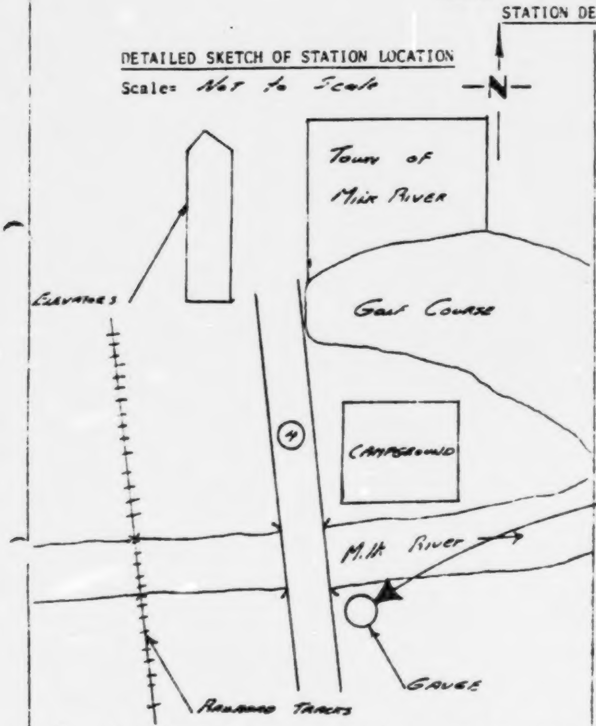
Information on dissolved solids is available as a by-product of the laboratory analyses for either suspended sediment concentration or for particle sizes. Data for 1981 to 1983 are depicted in plots of discharge versus dissolved solids concentration and can be found on pages D-46 to D-48. All available dissolved solids data has been tabulated and is contained on pages D-30 to D-35.

WATER SURVEY OF CANADA - CALGARY

STATION DESCRIPTION

DETAILED SKETCH OF STATION LOCATION

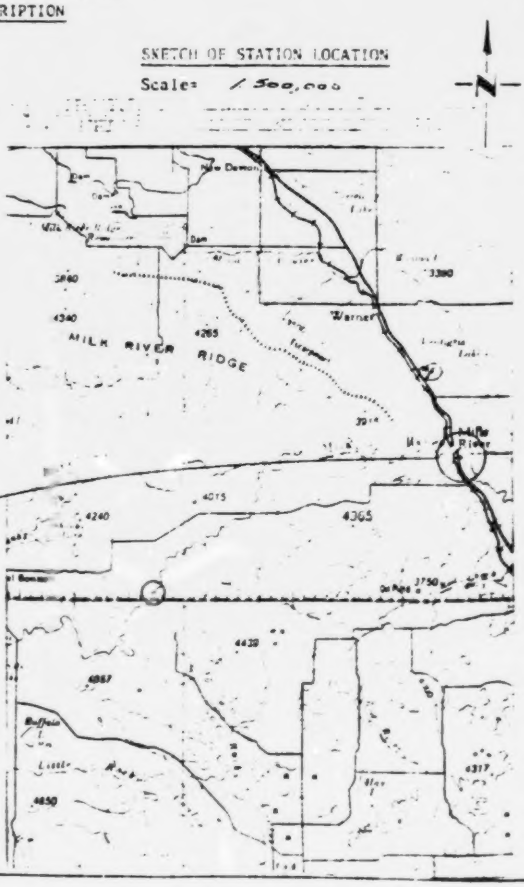
Scale= Not to Scale


N
Town of Milk River
Golf Course
Elevators
4
Campground
Milk River
Gauge
Railroad Tracks

Lower intake - 7.9m long., 0.076m diam. with coupling.
Elevation: 1037.408
Upper intake - 5.5m long., 0.076m diam. No coupling.
Elevation: 1037.920

SKETCH OF STATION LOCATION

Scale= 1:500,000


N
New Dayton
Milk River Ridge
Warner
Milk River
3390
4340
4285
4240
4015
4365
3750
4430
4650
4317

ORIGINAL

STATION DESCRIPTION

Station No. 11AA005 Basin ______

Station Name Milk River at Milk River

Located in NE 1/4 Sec. 21 Tp. 2 Rge. 16, W4th

Latitude 49°08'37" Longitude 112°04'44"

Established May 18/09. by Water Survey of Canada

Name of Observer ______

Address ______

Rate of Pay ______ Freq. of Obs. ______

Telemark 647-3650

Location of station with respect to towns, etc:
Approximately 24 km below confluence with North Milk River on right bank, 1.5m downstream from Hwy. #4 bridge on south side of Town of Milk River.

Description of gauge and equipment:
Recorder in 4.3m x 1.5m diam. well with steel shelter.
Telemark
Power with heat tape
I.G. 0 - 3.7m, E.C.G.
Ght.Floor 3.76

Measurement description:
High measurements are made from bridge with I.P. being on the right bank. Marked on downstream side of bridge in 1m sections with double marks every 10m. Wading at about 0.8m GH., approx. 200m above gauge.

Prepared by: RGH Date: October 24/83.

BENCH MARKS

Give elevation of bench marks, type, and number or markings, and gauge datum

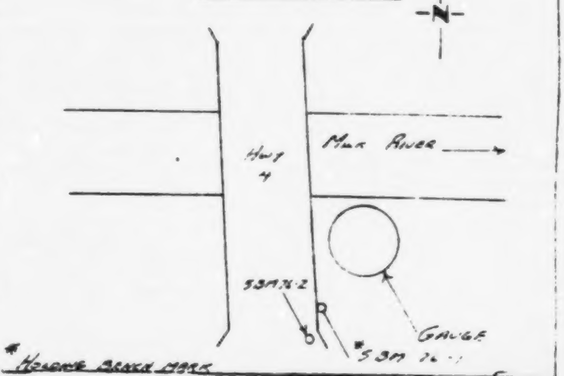
Gauge Datum= 1037.158

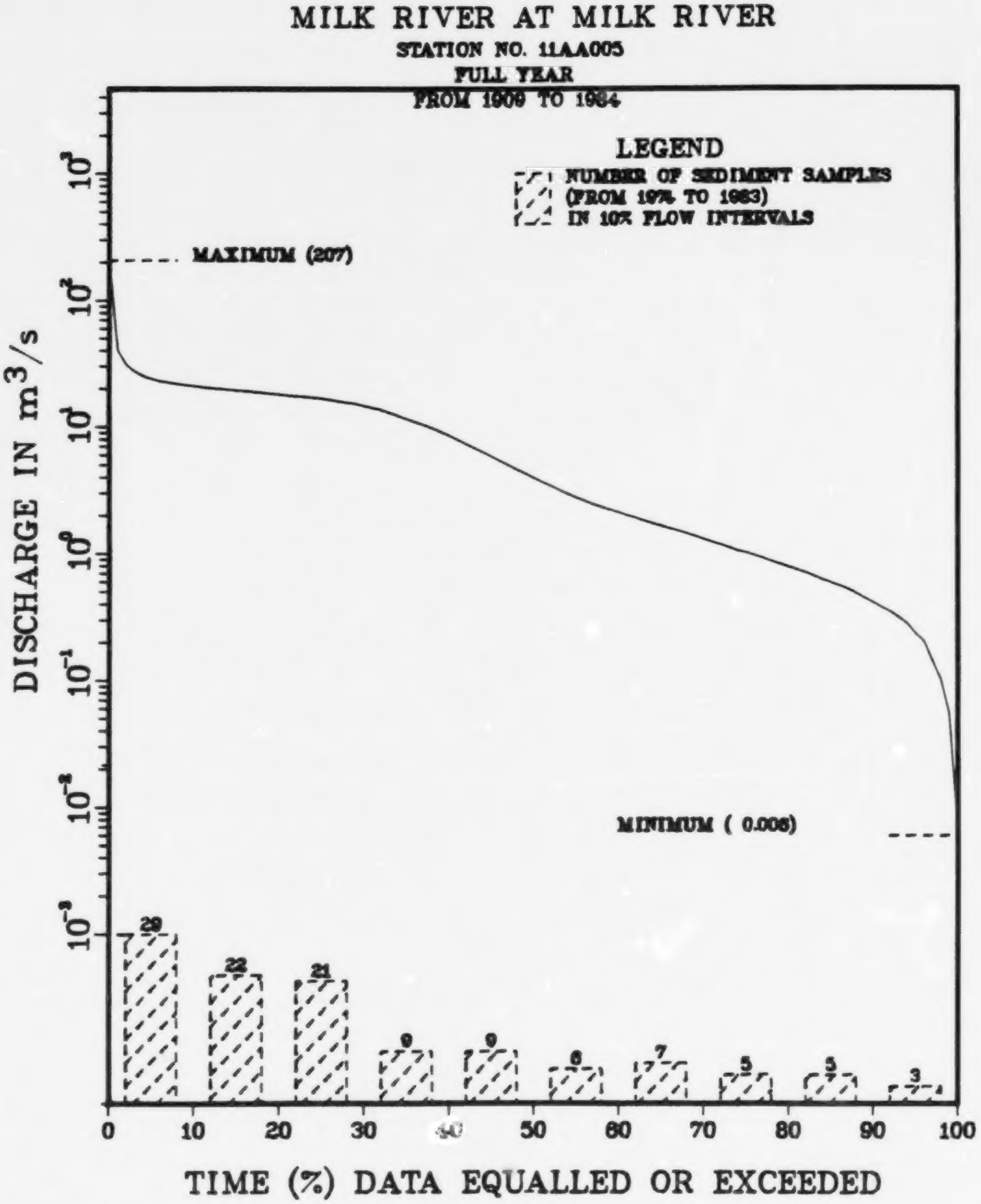
Geodetic 214C - In northeast face of east concrete wingwall on north bank of river 2.0m below coping of abandoned highway bridge abutments.
Elevation: 1039.272

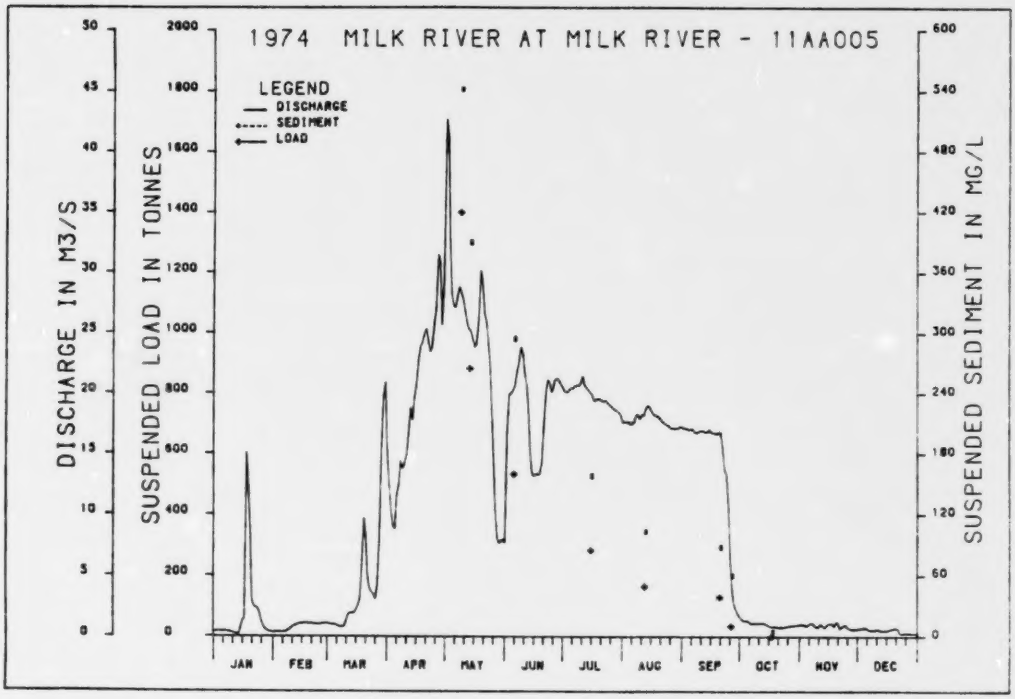
S.B.M. #76-1 - In southeast bedplate of highway bridge.
Elevation: 1041.477

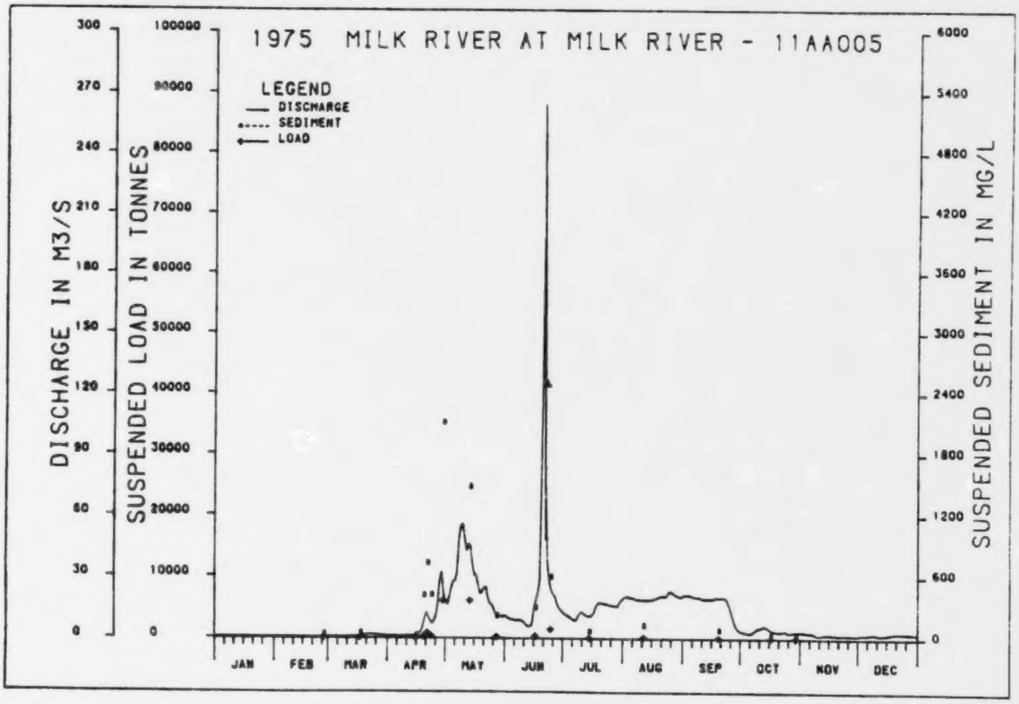
S.B.M. #76-2 - In southeast bedplate of highway bridge.
Elevation: 1043.327

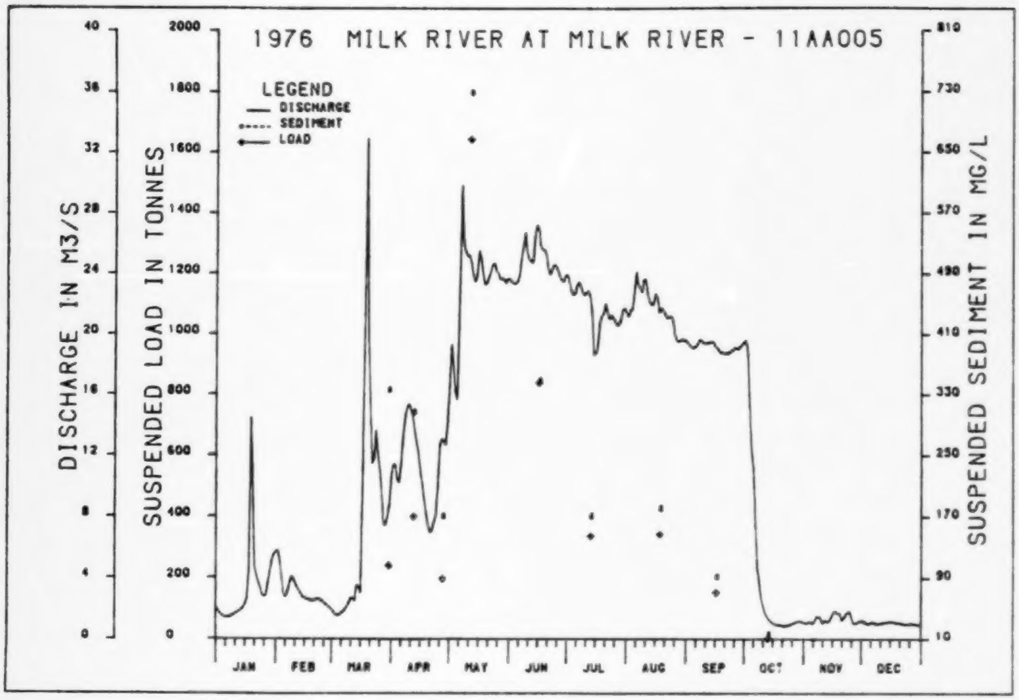
SKETCH OF BENCH MARKS

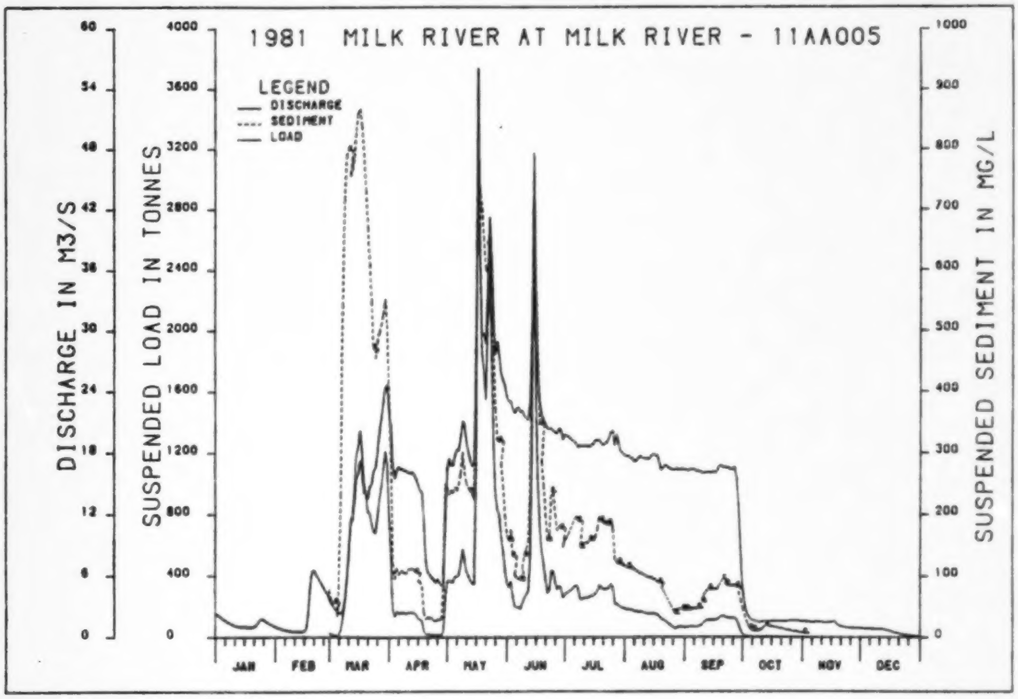

N
Hwy 4
Milk River
SBM 76-2
*SBM 76-1
Gauge
* Holding Bench Mark

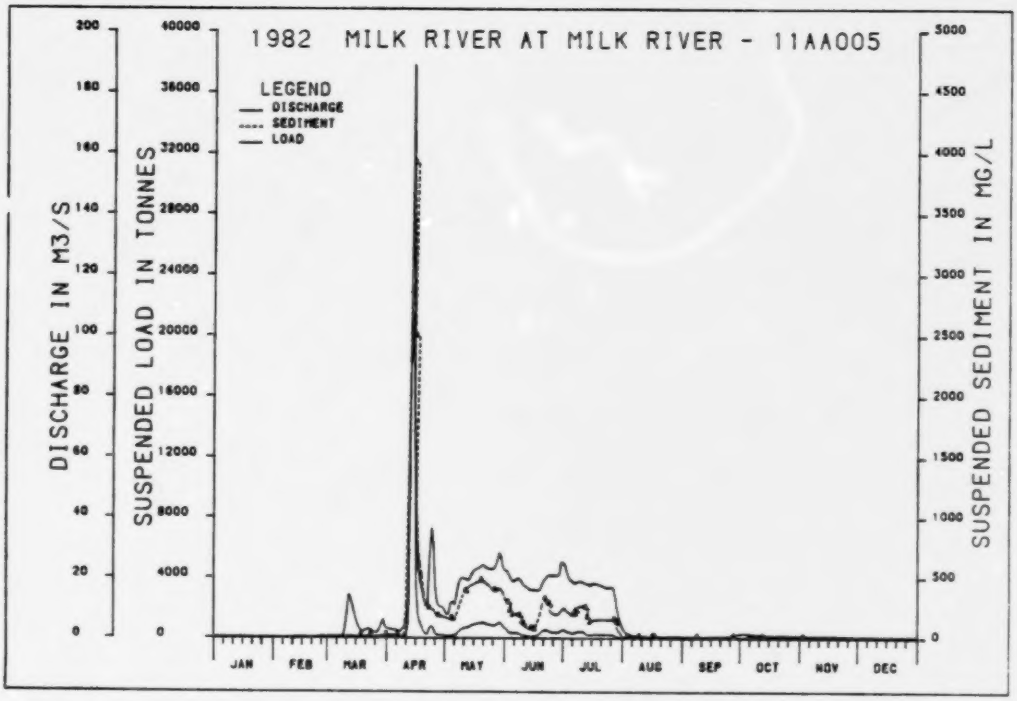

MILK RIVER AT MILK RIVER
STATION NO. 11AA005
FULL YEAR
FROM 1909 TO 1984
LEGEND
NUMBER OF SEDIMENT SAMPLES
(FROM 1975 TO 1983)
IN 10% FLOW INTERVALS
MAXIMUM (207)
MINIMUM (0.006)
DISCHARGE IN m³/s
10^3
10^2
10^1
10^0
10^{-1}
10^{-2}
10^{-3}
29
22
21
9
9
6
7
5
5
3
0
10
20
30
40
50
60
70
80
90
100
TIME (%) DATA EQUALLED OR EXCEEDED

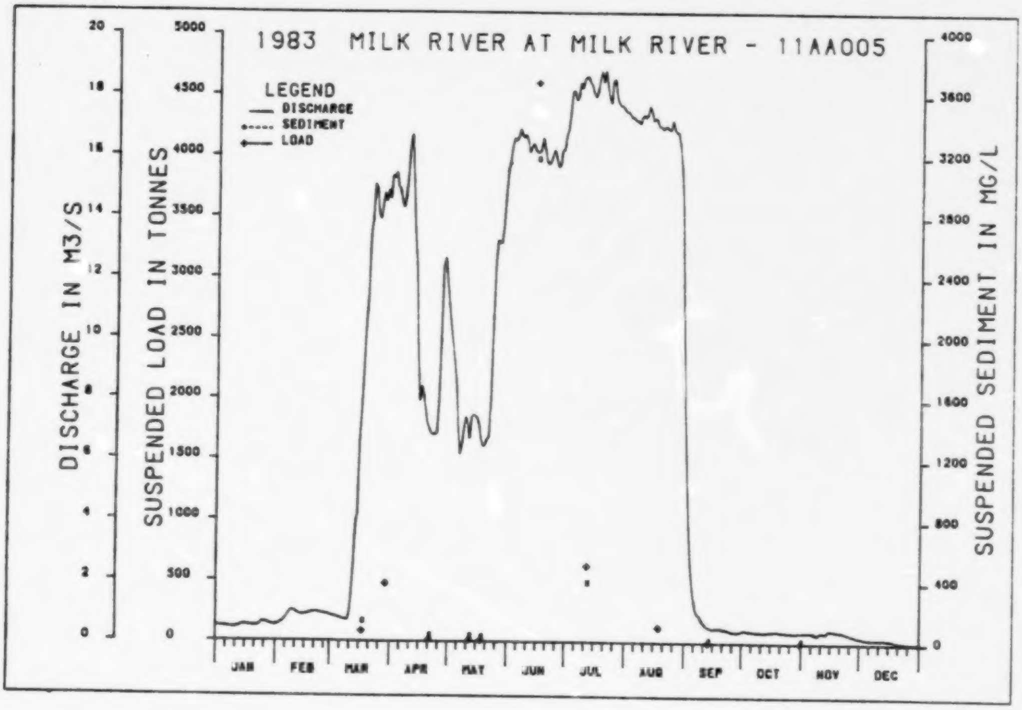

1974 MILK RIVER AT MILK RIVER - 11AA005
LEGEND
DISCHARGE
SEDIMENT
LOAD
DISCHARGE IN M3/S
0
5
10
15
20
25
30
35
40
45
50
SUSPENDED LOAD IN TONNES
0
200
400
600
800
1000
1200
1400
1600
1800
2000
SUSPENDED SEDIMENT IN MG/L
0
60
120
180
240
300
360
420
480
540
600
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC


1975 MILK RIVER AT MILK RIVER - 11AA005
LEGEND
DISCHARGE
SEDIMENT
LOAD
DISCHARGE IN M3/S
0
30
60
90
120
150
180
210
240
270
300
SUSPENDED LOAD IN TONNES
0
10000
20000
30000
40000
50000
60000
70000
80000
90000
100000
SUSPENDED SEDIMENT IN MG/L
0
600
1200
1800
2400
3000
3600
4200
4800
5400
6000
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC


1976 MILK RIVER AT MILK RIVER - 11AA005
LEGEND
DISCHARGE
SEDIMENT
LOAD
DISCHARGE IN M3/S
SUSPENDED LOAD IN TONNES
SUSPENDED SEDIMENT IN MG/L
0
4
8
12
16
20
24
28
32
36
40
0
200
400
600
800
1000
1200
1400
1600
1800
2000
10
90
170
250
330
410
490
570
650
730
810
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC


1981 MILK RIVER AT MILK RIVER - 11AA005
LEGEND
DISCHARGE
SEDIMENT
LOAD
DISCHARGE IN M3/S
SUSPENDED LOAD IN TONNES
SUSPENDED SEDIMENT IN MG/L
0
6
12
18
24
30
36
42
48
54
60
0
400
800
1200
1600
2000
2400
2800
3200
3600
4000
0
100
200
300
400
500
600
700
800
900
1000
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC


1982 MILK RIVER AT MILK RIVER - 11AA005
LEGEND
DISCHARGE
SEDIMENT
LOAD
DISCHARGE IN M3/S
0
20
40
60
80
100
120
140
160
180
200
SUSPENDED LOAD IN TONNES
0
4000
8000
12000
16000
20000
24000
28000
32000
36000
40000
SUSPENDED SEDIMENT IN MG/L
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC


1983 MILK RIVER AT MILK RIVER - 11AA005
LEGEND
DISCHARGE
SEDIMENT
LOAD
DISCHARGE IN M3/S
0
2
4
6
8
10
12
14
16
18
20
SUSPENDED LOAD IN TONNES
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
SUSPENDED SEDIMENT IN MG/L
0
400
800
1200
1600
2000
2400
2800
3200
3600
4000
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC

MILK RIVER AT MILK RIVER

MONTH	DAY	TIME	DISSOLVED SOLIDS (mg/L)	INSTANTANEOUS CONCENTRATION (mg/L)	DISCHARGE (m^3/s)
		INSTANTANEOUS DATA FOR 1984			
MAR	13	0750	178	14	0.418
MAR	28	0920	114	269	15.3
APR	10	0930	174	45	6.78
APR	24	1120	217	54	7.37
MAY	30	0735	94	434	17.8
JUN	26	1630	99	403	19.9
AUG	27	1830	139	20	2.18
OCT	31	1715	471	5	0.177
		INSTANTANEOUS DATA FOR 1983			
MAR	17	0915	185	122	8.12
MAR	29	1605	143	381	14.7
APR	21	0810	192	28	7.58
MAY	12	1130	212	24	7.06
MAY	18	1700	209	21	7.00
JUL	12	1300	97	393	19.2
AUG	18	0845	71	84	17.7
SEP	13	0930	263	3	0.549
OCT	31	1655	380	3	0.534
		INSTANTANEOUS DATA FOR 1982			
MAR	18	1705	345	12	2.79
MAR	23	1645	344	13	2.92
MAR	31	0910	326	17	3.77
APR	6	1600	393	9	2.63
JUN	14	1605	204	4948 M	90.5
JUN	14	1620		5349 M	90.5
JUN	14	1630		5207 M	90.5
JUN	14	1640		4870	90.5
JUN	14	1650		4781 M	90.5
JUN	14	1700		4424 M	90.5
JUN	15	1630		2112	58.4
JUN	21	1230	284	289	10.1
JUN	27	1625	250	176 M	12.3
JUN	27	1635	250	197 M	12.3
JUN	27	1640		215	12.3
JUN	27	1645		216 M	12.3

MILK RIVER AT MILK RIVER

INSTANTANEOUS DATA FOR 1982 (cont'd.)

MONTH	DAY	TIME	DISSOLVED SOLIDS (mg/L)	INSTANTANEOUS CONCENTRATION (mg/L)	DISCHARGE (m^3/s)
JUN	27	1650		184 M	12.3
JUN	27	1700		184 M	12.3
MAY	4	1055	306	184	12.3
MAY	11	1405		462	20.6
MAY	19	1510	164	568	24.5
MAY	26	1445	151	479	23.9
JUN	2	1010		358	23.2
JUN	3	1115	218	260	21.5
JUN	3	1105		217 M	21.5
JUN	3	1110		275 M	21.5
JUN	3	1115		296 M	21.5
JUN	3	1120		183 M	21.5
JUN	3	1125		138 M	21.5
JUN	8	1500		196	20.6
JUN	10	0815	194	125	18.8
JUN	14	1220	158	92 M	16.7
JUN	14	1225		80 M	16.7
JUN	14	1230		79	16.7
JUN	14	1240		77 M	16.7
JUN	14	1245		67 M	16.7
JUN	14	1250		68 M	16.7
JUN	15	1415	170	64	16.6
JUN	21	1700	143	322	19.9
JUN	23	0835	128	283	21.7
JUL	6	1635	119	183	19.4
JUL	7	1740	120	219	18.9
JUL	12	1710	109	230	18.9
JUL	13	1420	106	134 M	18.7
JUL	13	1424		180 M	18.7
JUL	13	1428		166 M	18.7
JUL	13	1436		174 M	18.7
JUL	13	1448		137 M	18.7
JUL	13	1430		150	18.7
JUL	27	1345	93	146	17.4
JUL	28	1215	121	120	14.5
AUG	3	1315	328	6	1.74
AUG	9	1230	319	3	0.741
AUG	16	1545	365	7	0.487
AUG	17	1545	352	7	0.481

MILK RIVER AT MILK RIVER

MONTH	DAY	TIME	DISSOLVED SOLIDS (mg/L)	INSTANTANEOUS CONCENTRATION (mg/L)	DISCHARGE (m^3/s)
INSTANTANEOUS DATA FOR 1982 (cont'd.)					
SEP	8	1850	384	2	0.396
SEP	27	1530	385	5	0.863
OCT	5	1245	406	6	1.53
OCT	5			5 M	1.53
OCT	5			6 M	1.53
OCT	5			6 M	1.53
OCT	5			7 M	1.53
OCT	5			7 M	1.53
OCT	12	1740	359	4	1.05
NOV	2	1010	974	4	0.811
INSTANTANEOUS DATA FOR 1981					
MAR	4	0910	325	38 M	2.82
MAR	4	0915		49 M	2.82
MAR	4	0920		49 M	2.82
MAR	4	0925		56 M	2.82
MAR	4	0930		54 M	2.82
MAR	4	0930		71	2.82
MAR	11	1300	183	835 M	7.92
MAR	11			808 M	7.92
MAR	11			768 M	7.92
MAR	11			797 M	7.92
MAR	11			802 M	7.92
MAR	11			822	7.92
MAR	24	1330	144	390 M	16.5
MAR	24			668 M	16.5
MAR	24			543	16.5
MAR	24			542 M	16.5
MAR	24			417 M	16.5
MAR	24			361 M	16.5
APR	15	0935		135	16.0
MAY	13		173	158 M	18.1
MAY	13			362 M	18.1
MAY	13			218 M	18.1
MAY	13			244	18.1
MAY	13			310 M	18.1
MAY	13			193 M	18.1

MILK RIVER AT MILK RIVER

MONTH	DAY	TIME	DISSOLVED SOLIDS (mg/L)	INSTANTANEOUS CONCENTRATION (mg/L)	DISCHARGE (m^3/s)
		INSTANTANEOUS DATA FOR 1981 (cont'd.)			
MAY	21	1020	244	475 M	34.2
MAY	21			482 M	34.2
MAY	21			594 M	34.2
MAY	21			790 M	34.2
MAY	21	1120		691 M	34.2
MAY	21	1125		821	34.2
MAY	28	0930	207	473	28.9
JUN	2	0740	171	220	24.0
JUN	4	0905	119	211	23.2
JUN	8	1405	97	134	22.9
JUN	10	1200	100	201	22.1
JUN	18		150	364 M	24.9
JUN	18			581 M	24.9
JUN	18	0855		475	24.9
JUN	18			317 M	24.9
JUN	18			238 M	24.9
JUN	18			232 M	24.9
JUN	18			560 M	24.9
JUN	22	1530	117	216	21.8
JUN	24	0920	108	349	21.2
JUN	29	1255	100	253	21.0
JUL	8	1000	83	253	19.8
JUL	9	0950	83	185	20.4
JUL	14	1510	117	146 M	19.7
JUL	14	1520		258 M	19.7
JUL	14	1525		201	19.7
JUL	14	1530		206 M	19.7
JUL	14	1540		124 M	17.7
JUL	14	1550		94 M	19.7
JUL	20	1415	115	230	19.9
JUL	23	1400	109	232	19.8
JUL	29	1330	124	163	19.7
AUG	19	0951	104	65 M	18.1
AUG	19	0957		100 M	18.1
AUG	19	1003		115 M	18.1
AUG	19	1015		149 M	18.1
AUG	19	1019		76 M	18.1
AUG	19	1010		162	18.1
AUG	19	1410		89	18.1
AUG	27	0800	97	66	17.1

MILK RIVER AT MILK RIVER

MONTH	DAY	TIME	DISSOLVED SOLIDS (mg/L)	INSTANTANEOUS CONCENTRATION (mg/L)	DISCHARGE (m^3/s)
		INSTANTANEOUS DATA FOR 1981 (cont'd.)			
AUG	31	1310	91	76	17.1
SEP	2	0915	97	66	17.0
SEP	8	1340	93	65	16.9
SEP	10	0920	89	72	16.7
SEP	14	1540	91	75 M	16.8
SEP	14	1550		95 M	16.8
SEP	14	1555		99	16.8
SEP	14	1600		136 M	16.8
SEP	14	1605		52 M	16.8
SEP	14	1610		43 M	16.8
SEP	21	1240	101	109	17.3
SEP	23	1445	97	96	17.3
SEP	28	1225	107	111	15.8
OCT	5	1200	246	13	1.90
OCT	7	0940	285	11	1.68
OCT	13	1335	384	20	1.68
NOV	2	1605	360	7	1.62
		INSTANTANEOUS DATA FOR 1976			
MAR	30	1640	295	346	8.01
APR	12	1720	236	316	15.0
APR	27	1140	225	174	13.6
MAY	11	1250	191	756	26.6
JUN	16	1945	156	359	28.1
JUL	13	1330	114	174	23.3
AUG	18	1110	98	185	21.8
SEP	16	1310	99	92	20.3
OCT	13	1205	277	14	1.55
		INSTANTANEOUS DATA FOR 1975			
FEB	26		452	17	0.088
MAR	17	1600	302	26	0.694
APR	15	0925	307	6	1.07
APR	19	1710	188	410	4.84
APR	21	1440	201	740	13.0
APR	23	1000	190	414	8.86
APR	29	0925	197	2183	37.1

MILK RIVER AT MILK RIVER

MONTH	DAY	TIME	DISSOLVED SOLIDS (mg/L)	INSTANTANEOUS CONCENTRATION (mg/L)	DISCHARGE (m^3/s)
INSTANTANEOUS DATA FOR 1975 (cont'd.)					
MAY	13	0935	212	1522	52.4
MAY	27	0855	264	205	13.3
JUN	16	1805	224	289	15.5
JUN	21	1850	201	5125	199
JUN	22	1415	231	2581	67.7
JUN	24	1600	304	602	26.9
JUL	14	1610	238	47	10.8
AUG	11	1750	115	113	19.1
SEP	19	0930	115	64	20.7
OCT	16	1020	348	26	4.70
OCT	29	1720	360	14	3.40
INSTANTANEOUS DATA FOR 1974					
MAY	8	0940	148	347 M	29.4
MAY	8	0945		424 M	29.4
MAY	8	0950		592 M	29.4
MAY	8	0955		616	29.4
MAY	8	1000		745 M	29.4
MAY	8	1005		703 M	29.4
MAY	13	1300	120	404	26.3
JUN	5	0910	143	190 M	20.5
JUN	5	0915		233 M	20.5
JUN	5	0920		345 M	20.5
JUN	5	0925		373	20.5
JUN	5	0930		428 M	20.5
JUN	5	0935		294 M	20.5
JUL	15	1225	105	162	20.8
AUG	12	1330	89	105	18.4
SEP	20	0920	78	89	17.6
SEP	26	1410	97	60	6.71
OCT	17	1700	311	3	0.861

M - MEASUREMENT

MILK RIVER AT MILK RIVER - STATION NO. 11AA005

SUSPENDED SEDIMENT FOR 1981

DAY	JAN				FEB				MAR				DAY
	TEMP. (°C)	DAILY DISCHARGE (m^3/s)	MEAN CON-CENTRATION (mg/L)	DAILY LOAD (t)	TEMP. (°C)	DAILY DISCHARGE (m^3/s)	MEAN CON-CENTRATION (mg/L)	DAILY LOAD (t)	TEMP. (°C)	DAILY DISCHARGE (m^3/s)	MEAN CON-CENTRATION (mg/L)	DAILY LOAD (t)	
1		2.39 B				1.04 B				3.81 B	80	26.3	1
2		2.26 B				0.951 B				3.40 B	64	18.8	2
3		2.14 B				0.867 B				3.11 B	58	15.6	3
4		1.97 B				0.809 B			0.3	2.83 B	58 S	14.2	4
5		1.80 B				0.750 B				2.61 B	36	8.12	5
6		1.68 B				0.679 B				2.40 B	84	17.4	6
7		1.54 B				0.640 B				2.40 B	243	50.4	7
8		1.43 B				0.607 B				2.61 B	565	127	8
9		1.32 B				0.568 B				3.61 B	747	233	9
10		1.24 B				0.549 B				5.41 B	822	384	10
11		1.14 B				0.542 B			2.0	7.91 B	831 S	568	11
12		1.07 B				0.542 B				11.6	787	789	12
13		1.04 B				0.529 B				12.0	798	827	13
14		1.02 B				0.549 B				13.9	820	985	14
15		1.03 B				0.562 B				16.4	866	1 230	15
16		1.05 B				0.601 B				16.6	897	1 290	16
17		1.02 B				0.815 B				18.0	903	1 400	17
18		0.982 B				2.40 B				16.8	873	1 270	18
19		0.967 B				5.01 B				14.7 B	825	1 050	19
20		0.989 B				6.69 B				14.8 B	761	973	20
21		1.05 B				6.80 B				14.1 B	697	849	21
22		1.20 B				6.41 B				15.4 B	634	844	22
23		1.45 B				6.10 B				15.6 B	570	768	23
24		1.76 B				5.67 B			7.0	17.0	489 S	718	24
25		1.87 B				5.41 B				17.3	473	707	25
26		1.78 B				5.01 B				18.8	501	814	26
27		1.60 B				4.60 B				21.0	518	940	27
28		1.45 B				4.41 B				22.3	530	1 020	28
29		1.33 B								23.9	550	1 140	29
30		1.24 B								25.4	575	1 260	30
31		1.14 B								25.7	530	1 180	31
TOTAL		43.948				70.110				391.40		21 516.82	TOTAL
MEAN		1.42				2.50				12.6		694	MEAN

DAY	APR				MAY				JUN				DAY
	TEMP. (°C)	DAILY DISCHARGE (m^3/s)	MEAN CON-CENTRATION (mg/L)	DAILY LOAD (t)	TEMP. (°C)	DAILY DISCHARGE (m^3/s)	MEAN CON-CENTRATION (mg/L)	DAILY LOAD (t)	TEMP. (°C)	DAILY DISCHARGE (m^3/s)	MEAN CON-CENTRATION (mg/L)	DAILY LOAD (t)	
1		22.9	410	811		17.2	254	377		24.4	173	365	1
2		21.4	304	562		18.2	243	382	12.0	24.0	164 S	340	2
3		17.3	124	185		17.5	249	376		24.0	182	377	3
4		16.2	98	137		17.5	245	370	14.0	23.2	137 S	275	4
5		17.1	117	173		18.6	255	410		22.8	105	207	5
6		17.4	106	159		19.1	249	411		23.3	101	203	6
7		17.1	111	164		19.0	259	425		23.4	100	202	7
8		17.1	113	167		20.4	279	492	17.0	22.9	97 S	192	8
9		17.0	109	160		22.0	314	597		23.0	118	234	9
10		16.9	107	156		21.6	280	523	15.0	22.5	139 S	270	10
11		16.8	115	167		19.8	260	445		22.3	151	291	11
12		16.7	115	166		18.8	254	413		22.1	164	313	12
13		16.8	116	168	9.0	18.0	246 S	383		24.3	258	542	13
14		16.5	115	164		17.4	242	364		32.4	516	1 440	14
15	6.0	16.1	109 S	152		17.7	235	359		49.6	681	2 920	15
16		15.5	94	126		30.3	506	1 320		33.0	577	1 650	16
17		14.9	94	121		57.6	782	3 890		26.1	462	1 040	17
18		14.7	85	108		39.0	766	2 580	13.0	24.1	361 S	752	18
19		11.5	42	41.7		30.7	729	1 930		22.6	297	580	19
20		7.73	31	20.7		30.9	680	1 820		22.2	257	493	20
21		6.56	34	19.3	16.0	29.9	623 S	1 610		21.7	208	390	21
22		6.33	32	17.5		36.6	674	2 130	15.0	21.2	165 S	302	22
23		5.99	33	17.1		42.9	672	2 490		21.2	177	324	23
24		5.81	28	14.1		38.8	575	1 930	12.0	21.2	247 S	452	24
25		5.50	27	12.8		32.1	484	1 340		21.0	245	445	25
26		5.86	30	15.2		28.8	386	960		20.8	208	374	26
27		5.53	29	13.9		30.1	334	869		20.7	181	324	27
28		5.24	31	14.0	15.0	28.6	332 S	820		21.3	189	348	28
29		5.17	84	37.5		26.7	294	678	18.0	21.0	185 S	336	29
30		12.2	260	274		26.1	256	577		20.1	154	267	30
31						25.5	206	454					31
TOTAL		391.82		4 343.8		817.4		31 725		722.4		16 248	TOTAL
MEAN		13.1		145		26.4		1 020		24.1		542	MEAN

MILK RIVER AT MILK RIVER - STATION NO. 11AA005

SUSPENDED SEDIMENT FOR 1981

	JUL				AUG				SEP				
DAY	TEMP. (°C)	DAILY DISCHARGE (m^3/s)	MEAN CONCENTRATION (mg/L)	DAILY LOAD (t)	TEMP. (°C)	DAILY DISCHARGE (m^3/s)	MEAN CONCENTRATION (mg/L)	DAILY LOAD (t)	TEMP. (°C)	DAILY DISCHARGE (m^3/s)	MEAN CONCENTRATION (mg/L)	DAILY LOAD (t)	DAY
1		20.6	165	294		18.5	122	195		17.1	46	68.0	1
2		20.5	170	301		18.4	120	191	15.0	17.0	47 S	69.0	2
3		20.4	176	310	20.0	18.4	119 S	189		16.9	49	71.5	3
4		20.2	184	321		18.3	119	188		17.1	50	73.9	4
5		20.0	192	332		18.2	117	184		17.1	50	73.9	5
6		19.9	201	346		17.9	115	178		17.1	49	72.4	6
7		19.7	205	349		17.9	113	175		16.9	49	71.5	7
8	12.0	19.3	197 S	329		18.2	112	176	21.0	16.9	50 S	73.0	8
9	14.0	19.5	153 S	258		18.4	109	173		16.9	54	78.8	9
10		19.5	153	258		18.3	109	172	17.0	16.7	60 S	86.6	10
11		19.5	159	268		18.2	106	167		16.7	71	102	11
12		19.5	161	271		18.1	104	163		16.8	77	112	12
13		19.4	161	270		18.1	102	160		16.8	81	118	13
14	16.0	19.4	165 S	277		18.2	101	159	17.0	16.8	82 S	119	14
15		19.6	168	284		18.5	102	163		16.7	82	118	15
16		19.7	169	288		18.6	99	159		16.9	82	120	16
17		20.1	170	295		18.5	98	157		16.7	82	118	17
18		20.0	185	320		18.5	95	152		17.0	83	122	18
19		20.1	204	354	19.0	17.8	92 S	141		17.4	89	134	19
20	21.0	19.7	197 S	335		17.0	86	126		17.5	95	144	20
21		19.5	194	327		17.3	80	120	13.0	17.3	98 S	146	21
22		19.8	192	328		17.5	73	110		17.3	93	139	22
23	20.0	19.8	191 S	327		17.4	67	101	12.0	17.3	88 S	132	23
24		20.3	195	342		17.2	60	89.2		17.2	88	131	24
25		20.9	200	361		17.1	54	79.8		17.1	88	130	25
26		21.0	184	334		17.0	47	69.0		17.1	88	130	26
27		19.5	134	226	18.0	17.1	40 S	59.1		17.3	88	132	27
28		20.6	127	226		17.2	43	63.9	12.0	16.2	86 S	120	28
29	20.0	19.7	126 S	214		17.0	49	72.0		13.2	77	87.8	29
30		18.9	125	204		17.1	48	70.9		8.73	64	48.3	30
31		18.7	124	200	17.0	17.1	48 S	70.9					31
TOTAL		615.3		9 149		553.0		4 273.8		497.73		3 141.7	TOTAL
MEAN		19.8		295		17.8		138		16.6		105	MEAN

	OCT				NOV				DEC				
DAY	TEMP. (°C)	DAILY DISCHARGE (m^3/s)	MEAN CONCENTRATION (mg/L)	DAILY LOAD (t)	TEMP. (°C)	DAILY DISCHARGE (m^3/s)	MEAN CONCENTRATION (mg/L)	DAILY LOAD (t)	TEMP. (°C)	DAILY DISCHARGE (m^3/s)	MEAN CONCENTRATION (mg/L)	DAILY LOAD (t)	DAY
1		5.20	50	22.5		1.60	8	1.11		0.944 B			1
2		3.50	39	11.8	8.0	1.63	7 S	0.99		0.921 B			2
3		2.60	28	6.29		1.61				0.900 B			3
4		2.18	21	3.96		1.59				0.893 B			4
5	7.0	1.90	14 S	2.30		1.56				0.893 B			5
6		1.73	12	1.79		1.52				0.880 B			6
7	9.0	1.68	11 S	1.60		1.58				0.867 B			7
8		1.64	11	1.56		1.59				0.848 B			8
9		1.55	12	1.61		1.60				0.841 B			9
10		1.48	12	1.53		1.57				0.861 B			10
11		1.60	14	1.94		1.56				0.861 B			11
12		1.62	17	2.38		1.52				0.841 B			12
13	2.5	1.59	20 S	2.75		1.51				0.822 B			13
14		1.61	20	2.78		1.55				0.770 B			14
15		1.62	19	2.66		1.53				0.731 B			15
16		1.62	18	2.52		1.55				0.672 B			16
17		1.65	17	2.42		1.61				0.620 B			17
18		1.64	17	2.41		1.64				0.542 B			18
19		1.67	16	2.31		1.32 B				0.483 B			19
20		1.62	15	2.10		1.19 B				0.439 B			20
21		1.65	15	2.14		1.11 B				0.389 B			21
22		1.63	14	1.97		1.06 B				0.351 B			22
23		1.63	13	1.83		1.02 B				0.312 B			23
24		1.63	12	1.69		1.00 B				0.269 B			24
25		1.68	12	1.74		0.982 B				0.231 B			25
26		1.72	11	1.63		0.959 B				0.212 B			26
27		1.70	10	1.47		0.951 B				0.180 B			27
28		1.68	10	1.45		0.951 B				0.169 B			28
29		1.69	10	1.46		0.959 B				0.151 B			29
30		1.67	9	1.30		0.959 B				0.140 B			30
31		1.63	8	1.13						0.129 B			31
TOTAL		58.01		97.02		40.781				18.162			TOTAL
MEAN		1.87		3.13		1.36				0.586			MEAN

SUMMARY FOR THE YEAR 1981

SUSPENDED SEDIMENT CONCENTRATION(mg/L)		SUSPENDED SEDIMENT LOAD(t/d)	
MAXIMUM DAILY	903 ON MAR 17	MAXIMUM DAILY	3 890 ON MAY 17
MINIMUM DAILY	7 ON NOV 02	MINIMUM DAILY	0.99 ON NOV 02

TYPE OF GAUGE - RECORDING
LOCATION - LAT 49 08 37 N
LONG 112 04 44 W
DRAINAGE AREA 2 720 km^2
REGULATED FLOW SINCE 1916
INTERNATIONAL GAUGING STATION

B - ICE CONDITIONS

S - SAMPLE(S) COLLECTED THIS DAY

SEDIMENT DATA PARTIALLY CONTRIBUTED BY UNITED STATES GEOLOGICAL SURVEY

MILK RIVER AT MILK RIVER - STATION NO. 11AA005

SUSPENDED SEDIMENT FOR 1982

DAY	JAN				FEB				MAR				DAY
	TEMP. (°C)	DAILY DISCHARGE (m^3/s)	MEAN CONCENTRATION (mg/L)	DAILY LOAD (t)	TEMP. (°C)	DAILY DISCHARGE (m^3/s)	MEAN CONCENTRATION (mg/L)	DAILY LOAD (t)	TEMP. (°C)	DAILY DISCHARGE (m^3/s)	MEAN CONCENTRATION (mg/L)	DAILY LOAD (t)	
1		0.118 B				0.020 B				0.400 B	12	0.41	1
2		0.118 B				0.020 B				0.330 B	12	0.34	2
3		0.118 B				0.020 B				0.290 B	12	0.30	3
4		0.118 B				0.020 B				0.260 B	12	0.27	4
5		0.118 B				0.010 B				0.240 B	12	0.25	5
6		0.118 B				0.010 B				0.220 B	12	0.23	6
7		0.118 B				0.015 B				0.210 B	12	0.22	7
8		0.110 B				0.015 B				0.210 B	12	0.22	8
9		0.100 B				0.018 B				0.400 B	12	0.41	9
10		0.100 B				0.018 B				2.70 B	12	2.80	10
11		0.100 B				0.050 B				8.50 B	12	8.81	11
12		0.110 B				0.090 B				15.0 B	12	15.6	12
13		0.140 B				0.130 B				13.3 B	12	13.8	13
14		0.190 B				0.190 B				10.8 B	12	11.2	14
15		0.200 B				0.240 B				8.40 B	12	8.71	15
16		0.190 B				0.290 B				6.00 B	12	6.22	16
17		0.180 B				0.270 B				3.90 B	12	4.04	17
18		0.140 B				0.200 B			0.1	2.79 B	12 S	2.89	18
19		0.120 B				0.140 B				2.30 B	12	2.38	19
20		0.100 B				0.130 B				2.20 B	12	2.28	20
21		0.060 B				0.170 B				2.90 B	12	3.01	21
22		0.040 B				0.220 B				3.00 B	13	3.37	22
23		0.040 B				0.290 B			0.1	2.92 B	13 S	3.28	23
24		0.030 B				0.400 B				2.70 B	13	3.03	24
25		0.030 B				0.500 B				1.90 B	13	2.13	25
26		0.048 B				0.580 B				1.70 B	13	1.91	26
27		0.040 B				0.530 B				2.00 B	13	2.25	27
28		0.030 B				0.460 B				2.90 B	13	3.26	28
29		0.030 B								4.70 B	14	5.69	29
30		0.040 B								6.50 B	20	11.2	30
31		0.030 B							0.1	3.77 B	19 S	6.19	31
TOTAL		3.024				5.046				113.440		126.70	TOTAL
MEAN		0.097				0.180				3.66		4.09	MEAN

DAY	APR				MAY				JUN				DAY
	TEMP. (°C)	DAILY DISCHARGE (m^3/s)	MEAN CONCENTRATION (mg/L)	DAILY LOAD (t)	TEMP. (°C)	DAILY DISCHARGE (m^3/s)	MEAN CONCENTRATION (mg/L)	DAILY LOAD (t)	TEMP. (°C)	DAILY DISCHARGE (m^3/s)	MEAN CONCENTRATION (mg/L)	DAILY LOAD (t)	
1		3.30 B	20	5.70		9.20	176	140		23.4	349	706	1
2		3.00 B	18	4.67		8.00	171	118	10.0	23.2	296 S	593	2
3		2.90 B	22	5.51		8.48	166	122	13.0	21.9	224 S	424	3
4		2.70 B	22	5.13	7.5	12.3	159 S	169		20.5	194	344	4
5		2.65 B	27	6.18		12.5	152	164		19.5	191	322	5
6	0.1	2.63 B	20 S	4.54		11.5	158	157		19.9	204	351	6
7		2.30 B	13	2.58		15.1	200	261		20.5	213	377	7
8		2.20 B	9	1.71		18.9	252	412	12.5	20.6	185 S	329	8
9		3.00 B	2	0.52		20.5	305	540		20.1	140	243	9
10		4.00 B	20	6.91		21.0	354	642	12.5	18.8	116 S	188	10
11		6.00 B	295	153	7.0	20.6	392 S	698		18.1	107	167	11
12		12.0 B	1 140	1 180		20.2	419	731		17.7	95	145	12
13		92.0 B	2 380	18 900		19.9	436	750		17.1	87	129	13
14	1.0	112 A	4 070 S	39 400		21.0	450	816	20.0	16.7	76 S	110	14
15	2.0	71.6	2 590 S	16 000		22.6	459	896	20.0	16.6	67 S	96.1	15
16		35.8	1 180	3 650		23.4	467	944		16.6	79	113	16
17		24.6	782	1 660		23.9	476	983		16.5	103	147	17
18		19.9	636	1 090		24.1	486	1 010		16.4	139	197	18
19		17.0	538	790	12.0	24.5	488 S	1 030		16.8	199	289	19
20		13.3	387	445		25.1	489	1 060		18.5	279	446	20
21	6.0	11.4	274 S	270		25.2	486	1 060	22.5	19.9	328 S	564	21
22		11.4	249	245		24.5	476	1 010		20.7	324	579	22
23		28.0 A	262	634		24.0	463	960	12.5	21.7	286 S	536	23
24		38.1 A	246	810		23.9	449	927		21.8	243	458	24
25		31.5	244	664		23.9	431	890		21.7	222	416	25
26		16.7	220	317	10.5	23.9	404 S	834		21.8	210	396	26
27	12.0	12.0	181 S	188		24.9	403	867		21.7	205	384	27
28		10.9	191	180		26.6	420	965		21.6	204	381	28
29		10.7	191	177		29.7	427	1 100		22.0	215	409	29
30		10.5	185	168		28.2	419	1 020		26.3	238	541	30
31						24.4	391	824					31
TOTAL		614.08		86 964.45		641.98		22 100		598.6		10 380.1	TOTAL
MEAN		20.5		2 900		20.7		713		20.0		346	MEAN

MILK RIVER AT MILK RIVER - STATION NO. 11AA005

SUSPENDED SEDIMENT FOR 1982

	JUL				AUG				SEP				
DAY	TEMP. (°C)	DAILY DISCHARGE (m^3/s)	MEAN CONCENTRATION (mg/L)	DAILY LOAD (t)	TEMP. (°C)	DAILY DISCHARGE (m^3/s)	MEAN CONCENTRATION (mg/L)	DAILY LOAD (t)	TEMP. (°C)	DAILY DISCHARGE (m^3/s)	MEAN CONCENTRATION (mg/L)	DAILY LOAD (t)	DAY
1		26.1	260	586		3.42	15	4.43		0.507 E	5	0.22	1
2		25.2	253	551		2.40	5	1.04		0.458 A	5	0.20	2
3		22.5	234	455	15.0	1.74	5 S	0.75		0.429 E	5	0.19	3
4		20.7	221	395		1.45	5	0.63		0.458 A	5	0.20	4
5		20.0	206	356		1.21	5	0.52		0.406	5	0.18	5
6	16.0	19.4	198 S	332		0.950	5	0.41		0.406	3	0.11	6
7	14.0	18.9	225 S	367		0.821	4	0.28		0.406	2	0.07	7
8		19.3	251	419		0.744	4	0.26	12.0	0.396	2 S	0.07	8
9		19.7	269	458	12.5	0.741	3 S	0.19		0.408	2	0.07	9
10		19.7	277	471		0.711	4	0.25		0.363	2	0.06	10
11		19.4	279	468		0.648	5	0.28		0.343	2	0.06	11
12	19.0	18.9	255 S	416		0.635	5	0.27		0.406 E	2	0.07	12
13	22.0	18.8	173 S	281		0.572	5	0.25		0.405 E	2	0.07	13
14		18.6	133	214		0.538	6	0.28		0.408 E	2	0.07	14
15		18.1	127	199		0.506	6	0.26		0.396 E	2	0.07	15
16		19.0	148	243	23.0	0.487	7 S	0.29		0.534	2	0.09	16
17		18.9	158	258	24.0	0.481	7 S	0.29		0.599	2	0.10	17
18		18.7	159	257		0.510	7	0.31		0.573	3	0.15	18
19		18.6	161	259		0.496	7	0.30		0.520	3	0.13	19
20		18.3	162	256		0.468	6	0.24		0.517	3	0.13	20
21		18.1	162	253		0.469	6	0.24		0.509	3	0.13	21
22		17.8	161	248		0.480	5	0.21		0.468	3	0.12	22
23		17.5	160	242		0.536 A	5	0.23		0.480	4	0.17	23
24		17.4	160	241		0.548 E	5	0.24		0.591	4	0.20	24
25		17.6	161	245		0.531 E	5	0.23		0.628	4	0.22	25
26		17.5	161	243		0.593 A	5	0.26		0.642	5	0.28	26
27	20.5	17.4	154 S	232		0.616 E	5	0.27	8.0	0.863 A	5 S	0.37	27
28	20.0	14.5	127 S	159		0.606 E	5	0.26		1.09	5	0.47	28
29		10.2	95	83.7		0.606 E	5	0.26		1.35	5	0.58	29
30		7.31	65	41.1		0.591 E	5	0.26		1.49	5	0.64	30
31		5.09	40	17.6		0.542 E	5	0.23					31
TOTAL		559.20		9 246.4		25.646		14.22		17.049		5.49	TOTAL
MEAN		18.0		298		0.827		0.46		0.568		0.18	MEAN

	OCT				NOV				DEC				
DAY	TEMP. (°C)	DAILY DISCHARGE (m^3/s)	MEAN CONCENTRATION (mg/L)	DAILY LOAD (t)	TEMP. (°C)	DAILY DISCHARGE (m^3/s)	MEAN CONCENTRATION (mg/L)	DAILY LOAD (t)	TEMP. (°C)	DAILY DISCHARGE (m^3/s)	MEAN CONCENTRATION (mg/L)	DAILY LOAD (t)	DAY
1		1.54	5	0.67		0.830 B	4	0.29		0.525 B			1
2		1.60	5	0.69	1.0	0.811 B	4 S	0.28		0.550 B			2
3		1.64	5	0.71		0.730 B				0.570 B			3
4		1.56	6	0.81		0.790 B				0.580 B			4
5	4.5	1.53	6 S	0.79		0.780 B				0.570 B			5
6		1.48	6	0.77		0.770 B				0.560 B			6
7		1.37	6	0.71		0.750 B				0.540 B			7
8		1.28	5	0.55		0.730 B				0.520 B			8
9		1.24	5	0.54		0.725 B				0.490 B			9
10		1.19	5	0.51		0.725 B				0.470 B			10
11		1.16	4	0.40		0.730 B				0.460 B			11
12	12.5	1.05	4 S	0.36		0.740 B				0.450 B			12
13		1.03	4	0.36		0.750 B				0.450 B			13
14		0.974	4	0.34		0.750 B				0.460 B			14
15		0.951	4	0.33		0.740 B				0.470 B			15
16		0.952	4	0.33		0.730 B				0.478 B			16
17		0.941	4	0.33		0.720 B				0.470 B			17
18		0.925	4	0.32		0.690 B				0.460 B			18
19		0.840	4	0.29		0.670 B				0.460 B			19
20		0.963	4	0.33		0.630 B				0.460 B			20
21		1.07	4	0.37		0.600 B				0.470 B			21
22		1.11	4	0.38		0.570 B				0.470 B			22
23		1.01	4	0.35		0.550 B				0.480 B			23
24		0.970	4	0.34		0.530 B				0.490 B			24
25		0.956	4	0.33		0.505 B				0.500 B			25
26		0.932	4	0.32		0.490 B				0.510 B			26
27		0.921	4	0.32		0.480 B				0.520 B			27
28		0.880	4	0.30		0.480 B				0.520 B			28
29		0.862	4	0.30		0.490 B				0.520 B			29
30		0.880 B	4	0.30		0.500 B				0.530 B			30
31		0.850 B	4	0.29						0.530 B			31
TOTAL		34.657		13.74		19.986				15.533			TOTAL
MEAN		1.12		0.44		0.666				0.501			MEAN

SUMMARY FOR THE YEAR 1982

SUSPENDED SEDIMENT CONCENTRATION(mg/L)	SUSPENDED SEDIMENT LOAD(t/d)
MAXIMUM DAILY 4 070 ON APR 14	MAXIMUM DAILY 39 400 ON APR 14

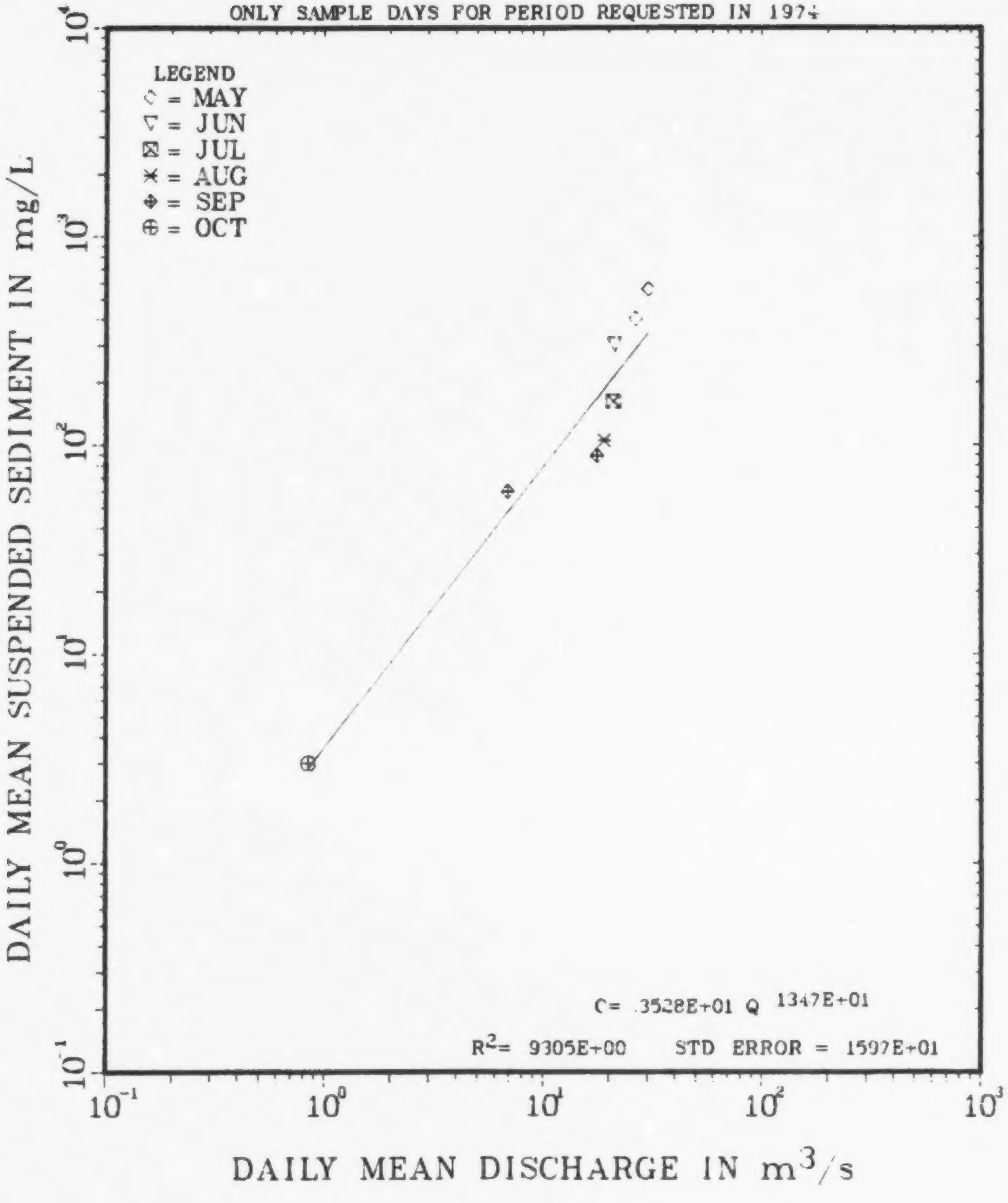
TYPE OF GAUGE - RECORDING
LOCATION - LAT 49 08 37 N
LONG 112 04 44 W
DRAINAGE AREA 2 720 km²
REGULATED FLOW SINCE 1916
INTERNATIONAL GAUGING STATION

A - MANUAL GAUGE B - ICE CONDITIONS E - ESTIMATED S - SAMPLE(S) COLLECTED THIS DAY

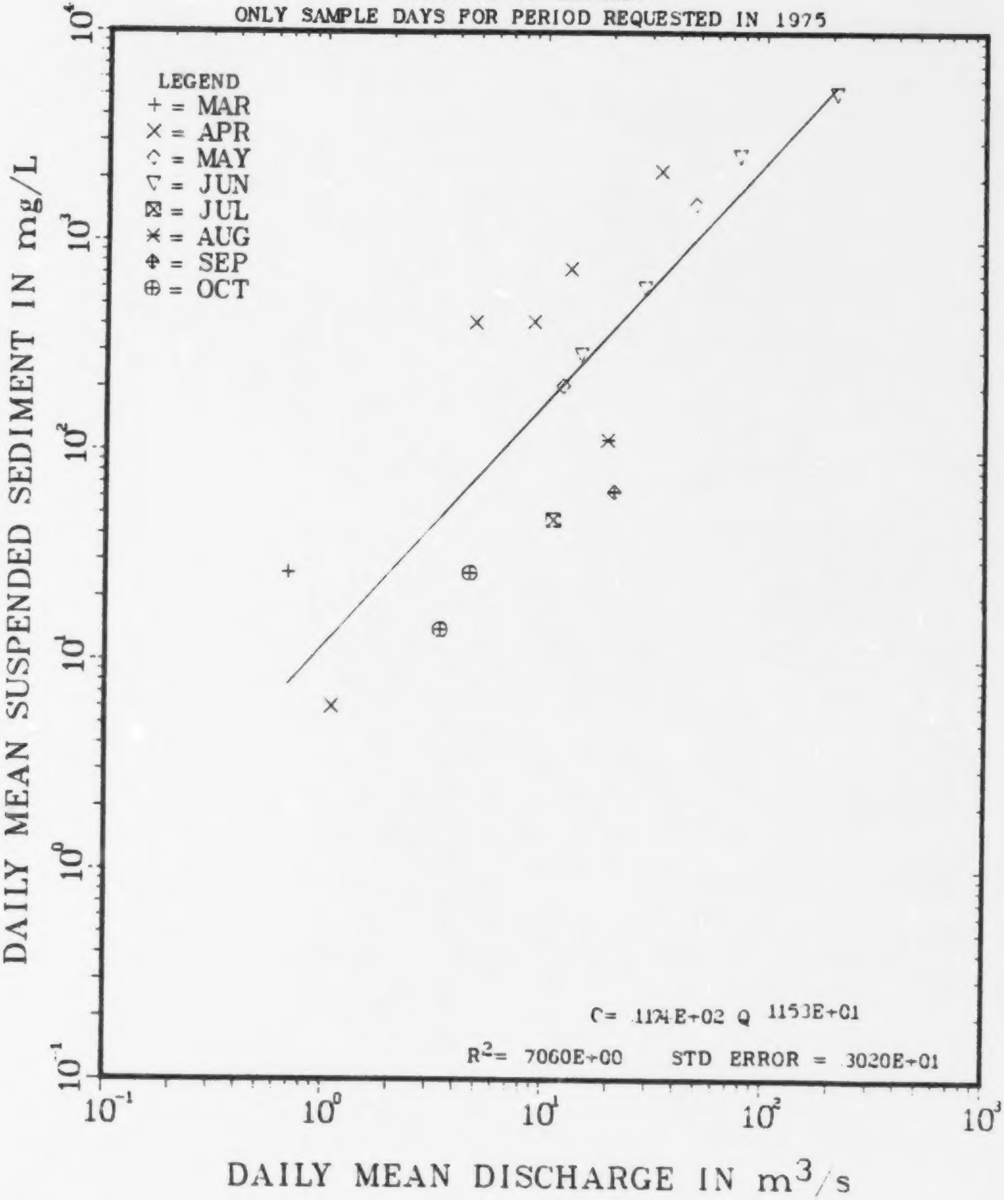
SEDIMENT DATA PARTIALLY CONTRIBUTED BY UNITED STATES GEOLOGICAL SURVEY

MILK RIVER AT MILK RIVER

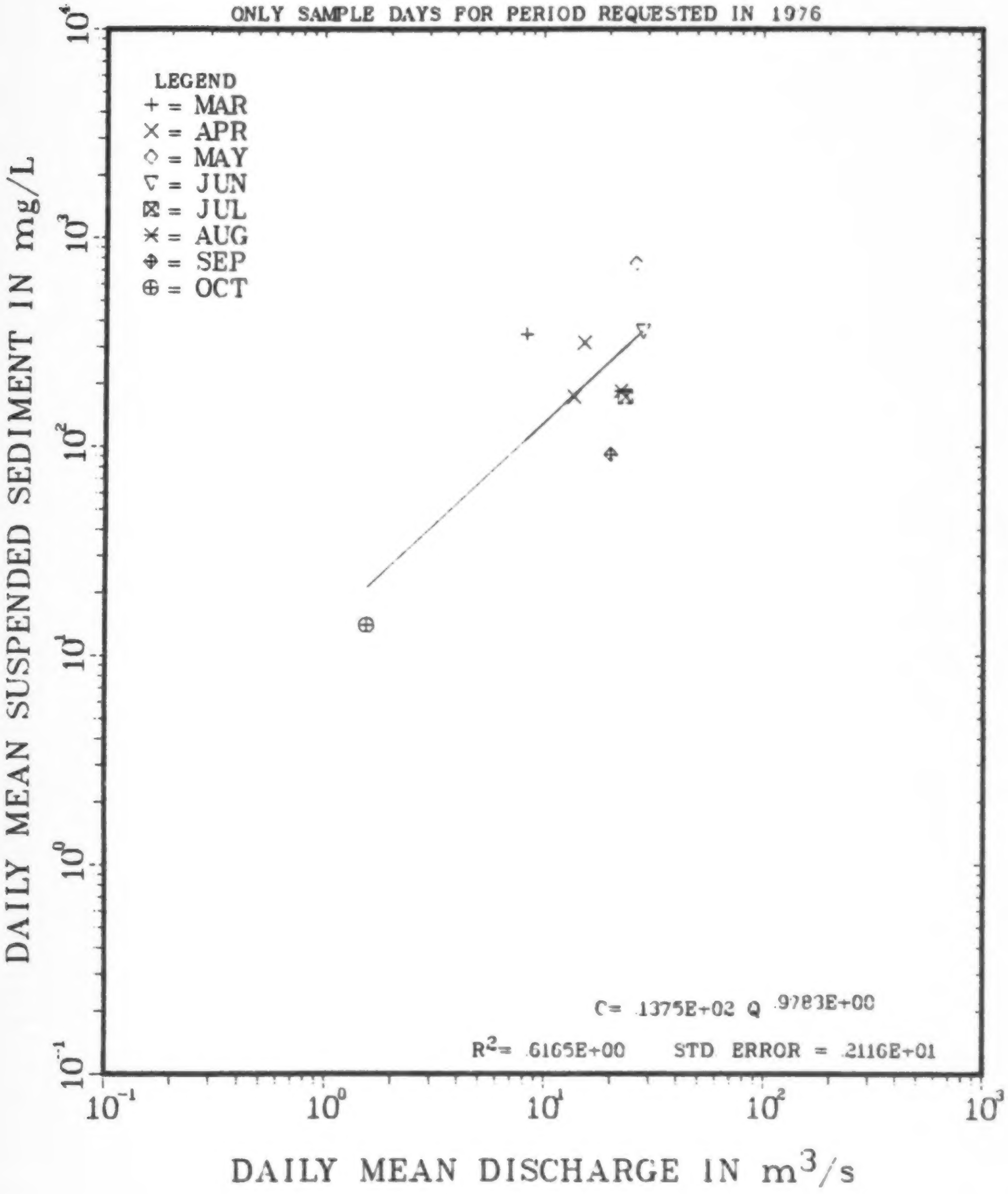
STATION NO. 11AA005
ONLY SAMPLE DAYS FOR PERIOD REQUESTED IN 1974



MILK RIVER AT MILK RIVER
STATION NO. 11AA005
ONLY SAMPLE DAYS FOR PERIOD REQUESTED IN 1975



MILK RIVER AT MILK RIVER
STATION NO. 11AA005
ONLY SAMPLE DAYS FOR PERIOD REQUESTED IN 1976



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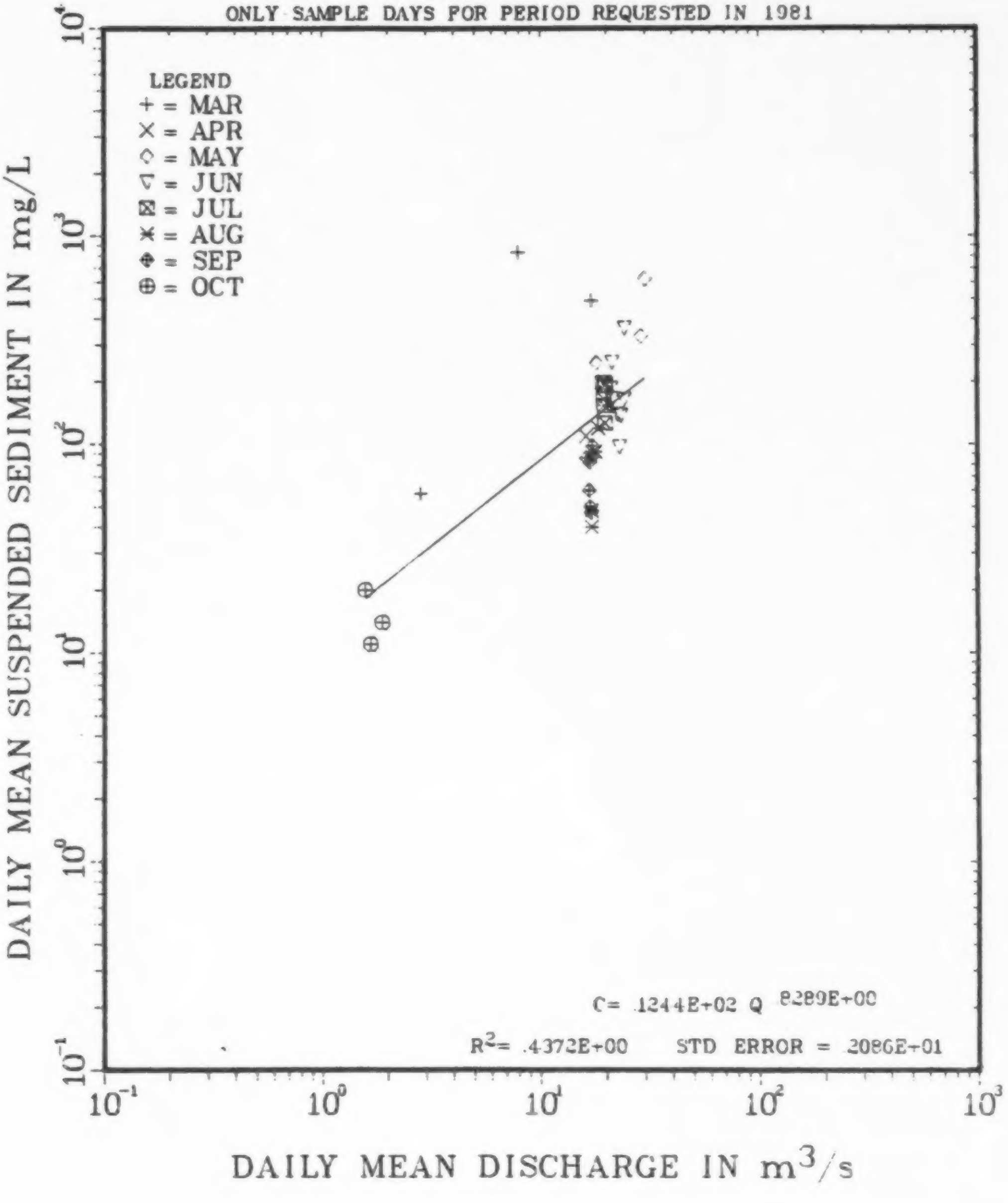
STATION NO. 11AA005
ONLY SAMPLE DAYS FOR PERIOD REQUESTED IN 1981



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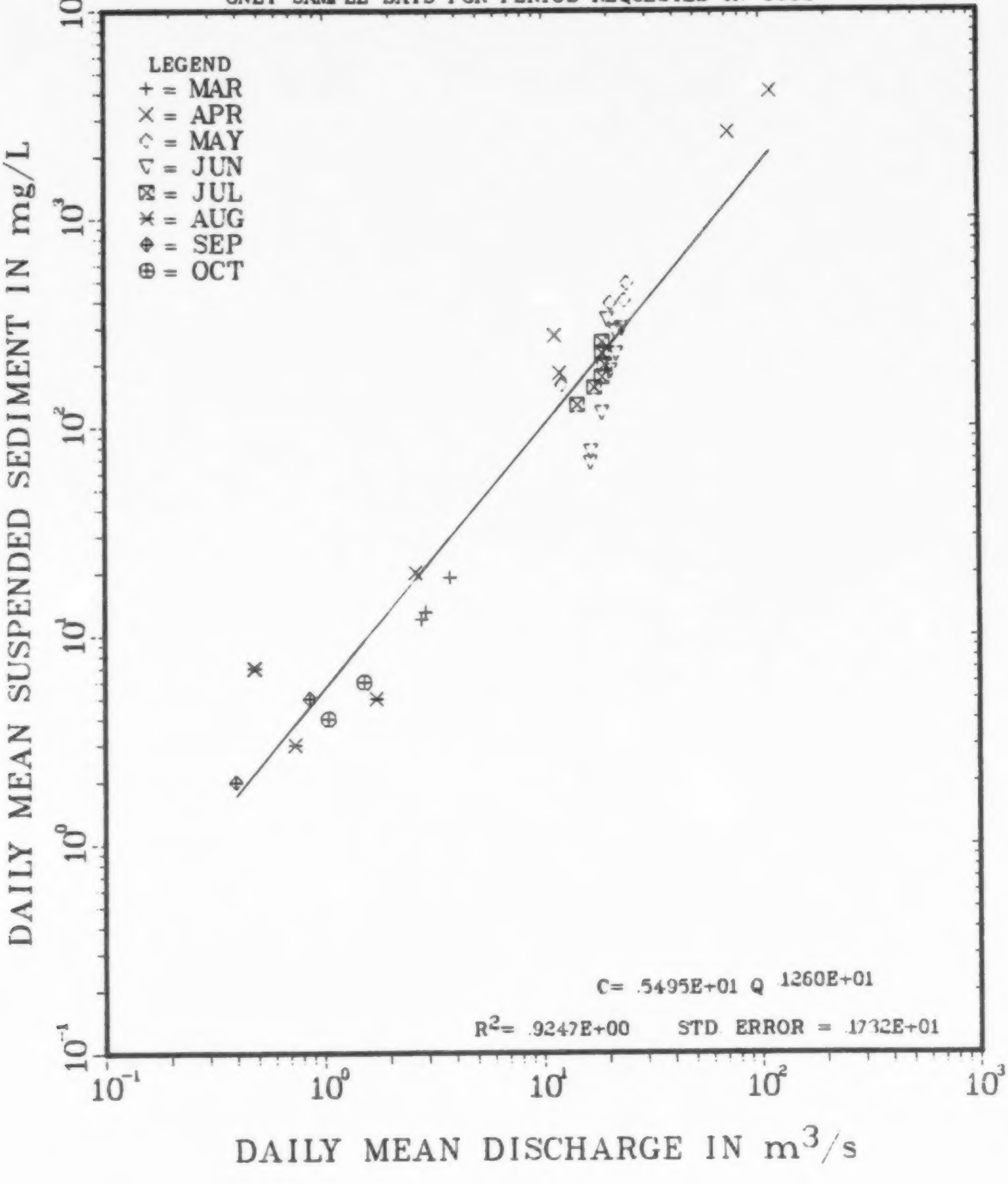
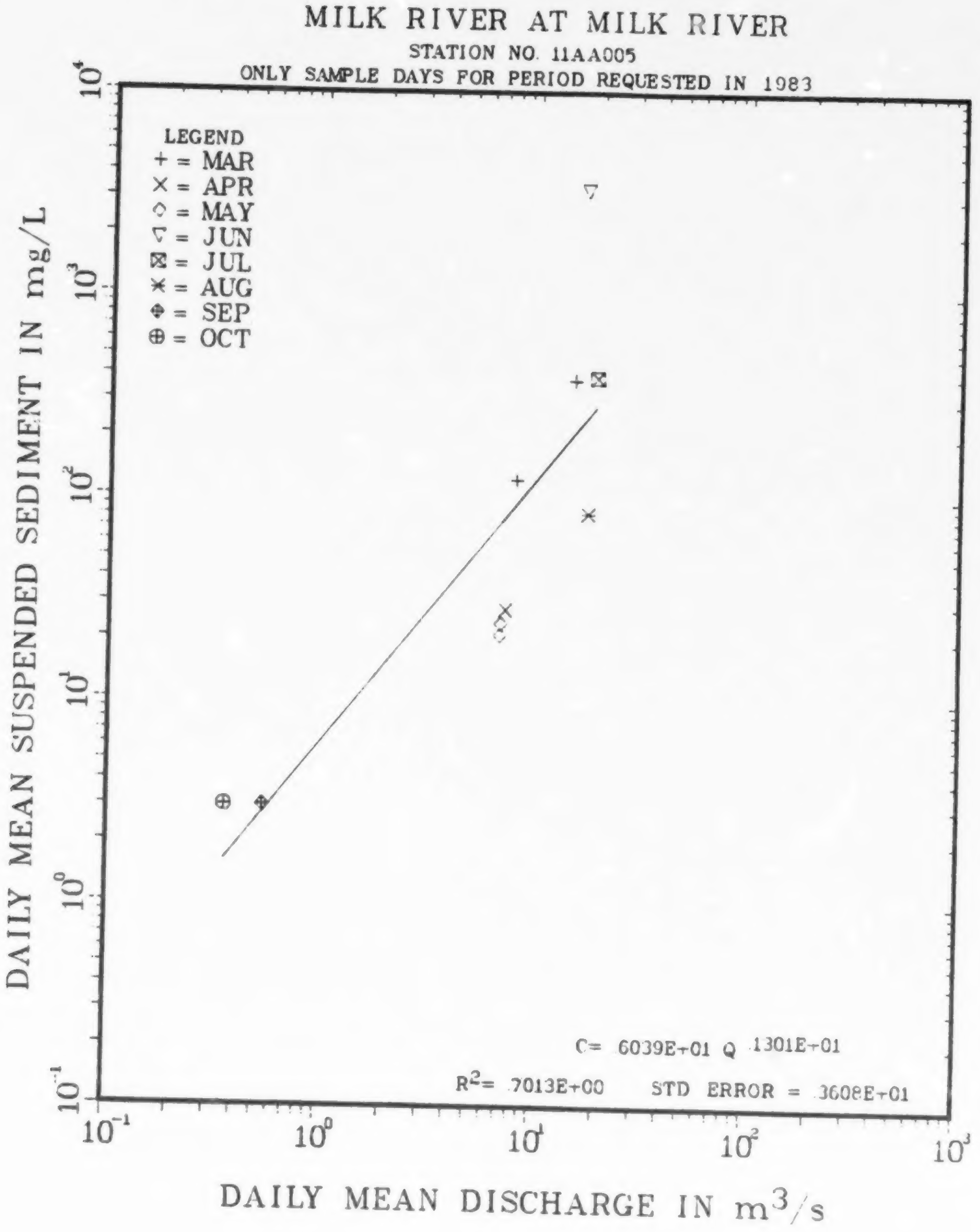
STATION NO. 11AA005
ONLY SAMPLE DAYS FOR PERIOD REQUESTED IN 1982

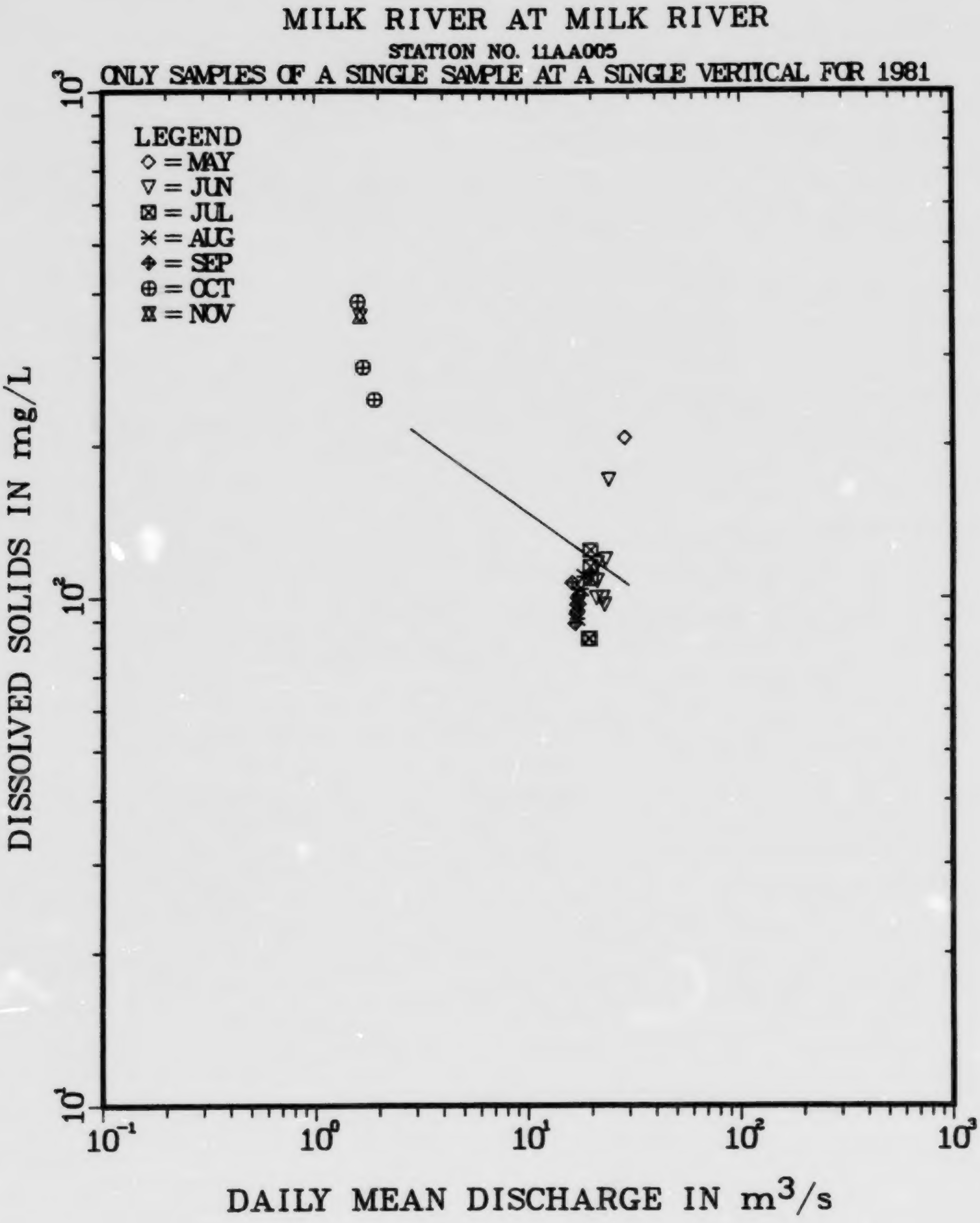


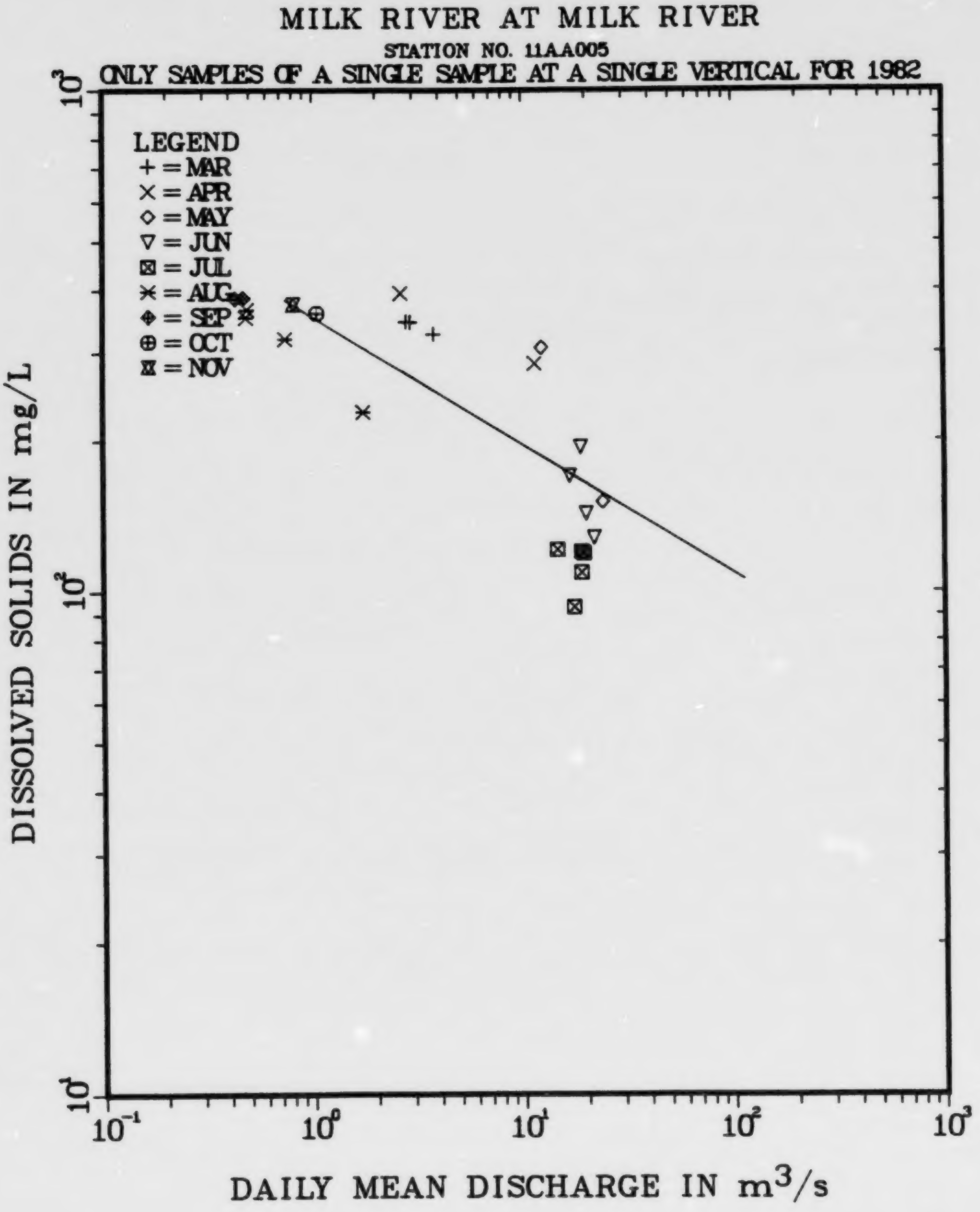


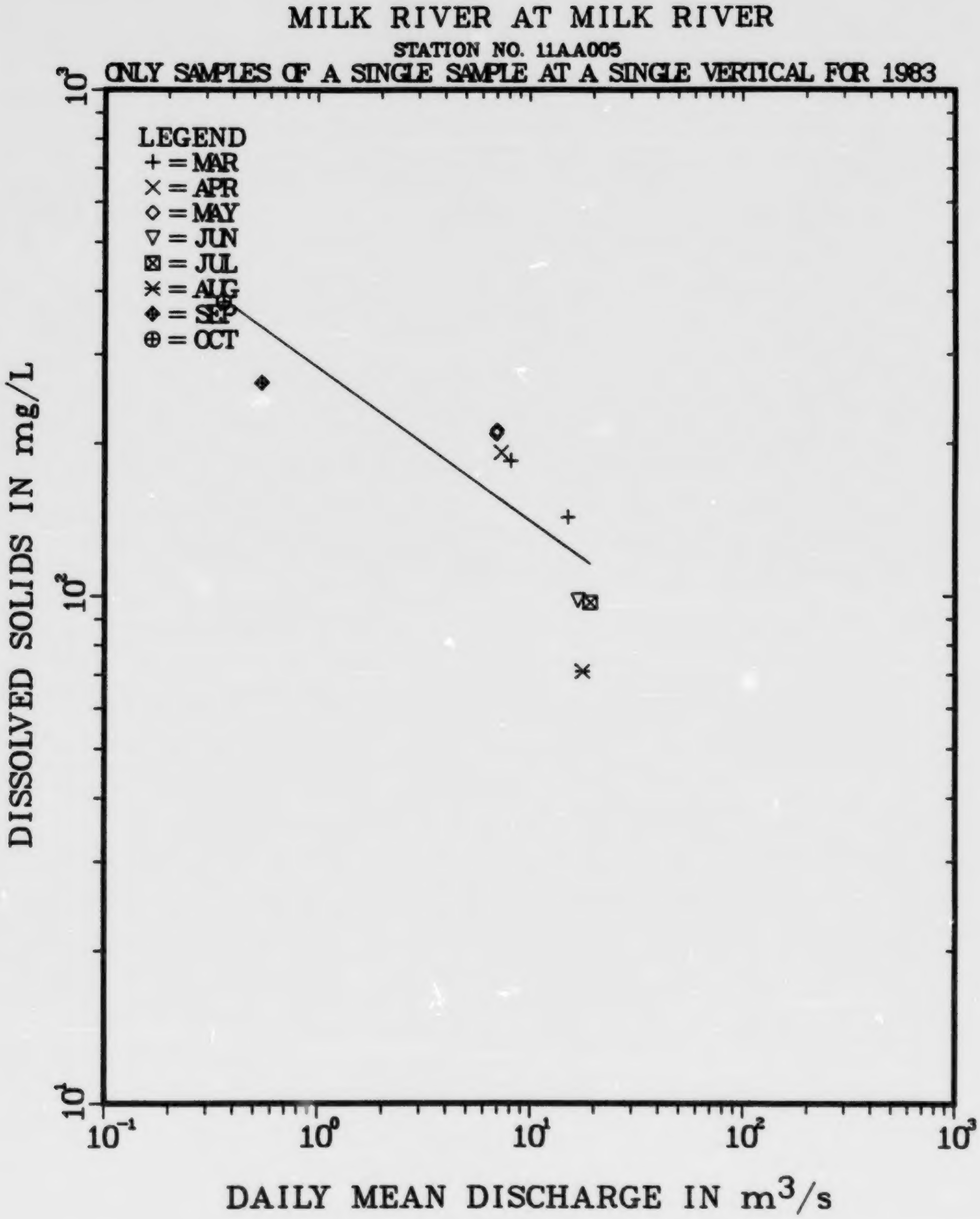
MILK RIVER AT MILK RIVER

STATION NO. 11AA005

ONLY SAMPLE DAYS FOR PERIOD REQUESTED IN 1983


MILK RIVER AT MILK RIVER
STATION NO. 11AA005
ONLY SAMPLES OF A SINGLE SAMPLE AT A SINGLE VERTICAL FOR 1981
LEGEND
◇ = MAY
▽ = JUN
⊠ = JUL
⋇ = AUG
◆ = SEP
⊕ = OCT
⧗ = NOV
DISSOLVED SOLIDS IN mg/L
10^3
10^2
10^1
10^{-1}
10^0
10^1
10^2
10^3
DAILY MEAN DISCHARGE IN m³/s


MILK RIVER AT MILK RIVER
STATION NO. 11AA005
ONLY SAMPLES OF A SINGLE SAMPLE AT A SINGLE VERTICAL FOR 1982
LEGEND
+ = MAR
× = APR
◇ = MAY
▽ = JUN
⊠ = JUL
✳ = AUG
⊕ = SEP
⊕ = OCT
⊠ = NOV
DISSOLVED SOLIDS IN mg/L
10^3
10^2
10^1
10^{-1}
10^0
10^1
10^2
10^3
DAILY MEAN DISCHARGE IN m³/s


MILK RIVER AT MILK RIVER
STATION NO. 11AA005
ONLY SAMPLES OF A SINGLE SAMPLE AT A SINGLE VERTICAL FOR 1983
LEGEND
+ = MAR
× = APR
◇ = MAY
▽ = JUN
⊠ = JUL
✱ = AUG
◆ = SEP
⊕ = OCT
DISSOLVED SOLIDS IN mg/L
10^3
10^2
10^1
10^{-1}
10^0
10^1
10^2
10^3
DAILY MEAN DISCHARGE IN m^3/s

APPENDIX E

MILK RIVER NEAR WRITING-ON-STONE PARK

11AA034

TABLE OF CONTENTS

MILK RIVER NEAR WRITING-ON-STONE PARK

Page

1.0 HYDROMETRIC STATION DESCRIPTION E-4

1.1 Period of Record E-4
1.2 Gauging Station Description E-4
1.3 Channel and Valley Features E-4
Table E-1: River Valley, Flat and Channel Features E-5
1.4 Stereo Pair E-6
Figure E-1: Stereo Pair Aerial Photograph E-6
1.5 On Site Photographs E-6

2.0 HYDRAULIC DATA E-8

2.1 Rating Curve E-8
Figure E-2: Stage-Discharge Relation E-8
2.2 Cross-Section E-9
Figure E-3: Cross-Section at Bridge Crossing E-9
2.3 Specific Gauge Diagram E-10
2.4 Discharge versus Area; Mean Velocity; Mean Depth E-10
Figure E-4: Discharge verus Cross-Sectional Area E-10
Figure E-5: Discharge versus Mean Velocity E-10
Figure E-6: Discharge verus Mean Depth E-11
Table E-2: Hydraulic Data at Bridge Crossing E-11

3.0 SUSPENDED SEDIMENT DATA E-13

3.1 Period of Sampling and Frequency E-13
Table E-3: Number of Suspended Sediment Samples E-13
3.2 Sampling Location, Procedures and Equipment E-13
3.3 Representativity E-14
3.4 Suspended Sediment Discharge Data E-14

4.0 SUSPENDED SEDIMENT PARTICLE SIZE DATA E-14

Table E-4: Particle Size Analysis Data of Depth-Integrated Suspended Sediment Samples E-15
Figure E-7: Composite Plot of Particle Size Analysis Data E-16

5.0 BED MATERIAL DATA E-14

6.0 BED LOAD DISCHARGE DATA E-14

7.0 DISSOLVED SOLIDS DATA E-14

TABLE OF CONTENTS

MILK RIVER NEAR WRITING-ON-STONE PARK

Page

DIAGRAMS AND TABLES OF DATA E-17

- Station Description E-17
- Flow Duration Curve E-18
- Streamflow and Sediment Hydrographs E-19
- Instantaneous Suspended Sediment Data E-20
- Annual Suspended Sediment Rating Curves E-22

MILK RIVER NEAR WRITING-ON-STONE PARK: 11AA034

1.0 HYDROMETRIC STATION DESCRIPTION

1.1 PERIOD OF RECORD

This gauging station was operated on a May to October basis from 1978 to 1982, inclusive. This station was established and operated as a part of a streamflow channel loss study of the Milk River system. In 1981 and 1982 a suspended sediment sampling program was conducted, as well.

1.2 GAUGING STATION DESCRIPTION

This gauging station was located on the downstream side of a bridge crossing of the Milk River in the SW 3-2-12-W4. The station consisted of a steel culvert (0.5m in diameter and 3.7m high) topped with a California shelter, which housed a float-driven Stevens A-71 strip chart recorder.

Streamflow measurements during high flows (>16 m^3/s) were made from the bridge, while at lower levels measurements were made by wading within 100 metres of the gauge.

A copy of the fieldman's description can be found on page E-17.

1.3 CHANNEL AND VALLEY FEATURES

The gauging station is located just upstream of the Writing-on-Stone Provincial park, an area of badlands and unique rock outcrops, on which Indian pictographs are inscribed. The significant features of the valley and river in the vicinity of the station are listed in Table E-1. These features are derived from aerial photograph interpretation and personal knowldge of the site. The classification of features are based on Kellerhals et al. (1976).

MILK RIVER NEAR WRITING-ON-STONE PARK

RIVER VALLEY, VALLEY FLAT AND CHANNEL FEATURES

	UPSTREAM OF GAUGE	DOWNSTREAM OF GAUGE
GENERAL DESCRIPTION IN VINCITY OF HYDROMETRIC STATION (ABOVE VALLEY)		
Terrain	Plains	Plains
Vegetation	Grass	Grass, shrubs
Land Use	Partly cultivated	Partly cultivated
VALLEY CHARACTERISTICS ABOVE VALLEY FLAT		
Slumping of Valley Walls	None	None
Vegetation on Valley Walls	Grass	Grass
TERRACES		
Terrace Presence	Fragmentary	Fragmentary
Number of Levels	Two	Two
RELATION OF CHANNEL TO VALLEY		
Valley Type	Stream cut valley	Stream cut valley
Relation of Channel to Valley Bottom	Entrenched	Not obviously aggrading or degrading
Relation of Channel to Valley Walls or to Resistant Terraces	Entrenched	Entrenched
DESCRIPTION OF VALLEY FLAT		
Presence	Fragmentary	Fragmentary
Lateral	Narrow (less than one stream width)	Narrow (less than one stream width)
Vegetation	Grass	Grass and shrubs
CHANNEL DESCRIPTION		
Channel Pattern	Irregular	Irregular
Islands	None	None
Type of Flow	Uniform with rapids in reach	Uniform with rapids in reach
Bar Type	Side and mid-channel bars	Point, side and mid-channel bars
LATERAL CHANNEL ACTIVITY		
Lateral Activity	Not detectable	Not detectable
Lateral Stability	Stable	Stable
CHANNEL BANKS AND BEDS		
Alluvial Bank Material	Sand and Silt	Sand and Silt
Non-Alluvial Bank Material	Moderately erodable rock	Moderately erodable rock
Predominant Bed Material	Sand	Sand

1.4 STEREO PAIR

Figure E-1 is a stereo pair of the gauging station site. The photographs were taken in October 1979 and the scale is 1:24 000.

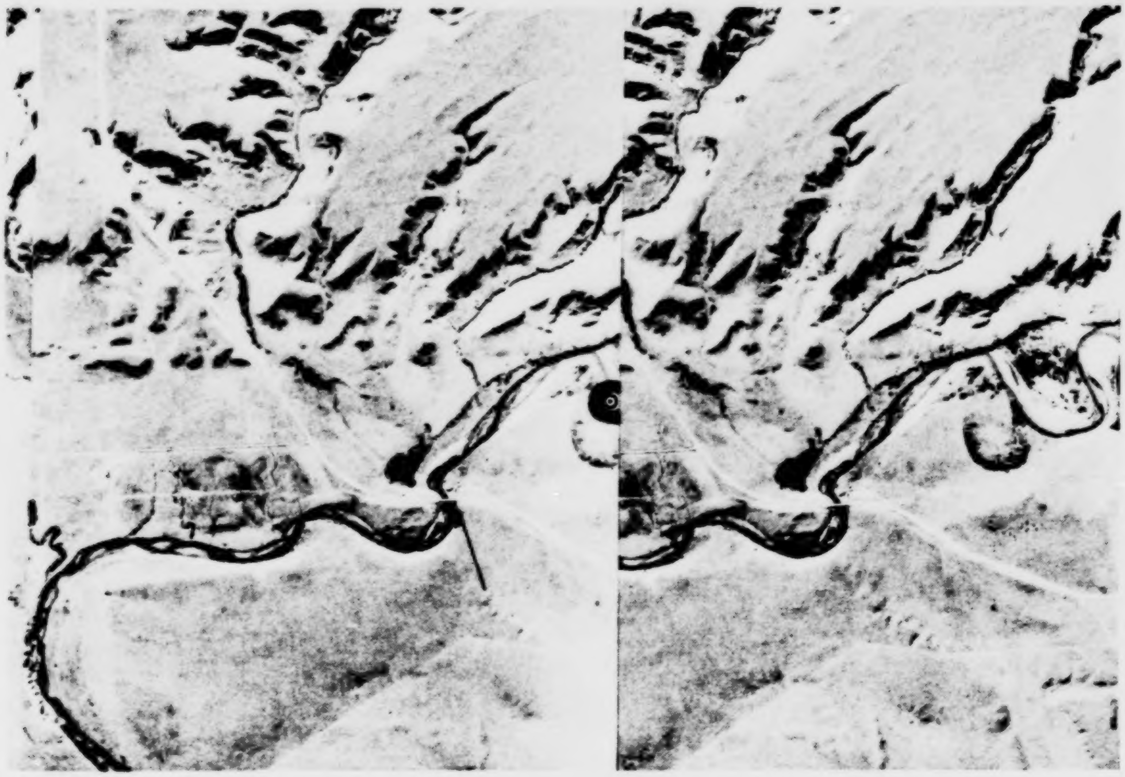


Figure E-1

Stereo Pair (Arrow Indicates Gauging Station)
Milk River near Writing-On-Stone Park

1.5 ON SITE PHOTOGRAPHS

Looking downstream from left bank.

Milk River near Writing-on-Stone

Looking upstream from left bank.

2.0 HYDRAULIC DATA

2.1 RATING CURVE

The stage-discharge relation for this station is depicted in Figure E-2. Two curves were used during the five year period; Curve No. 1 from 1979 to 1981 and Curve No. 2 in 1982. At lower flows, measurements scattered about the curves by plus or minus 0.05 metres, which is indicative of bed changes due to dune progression.

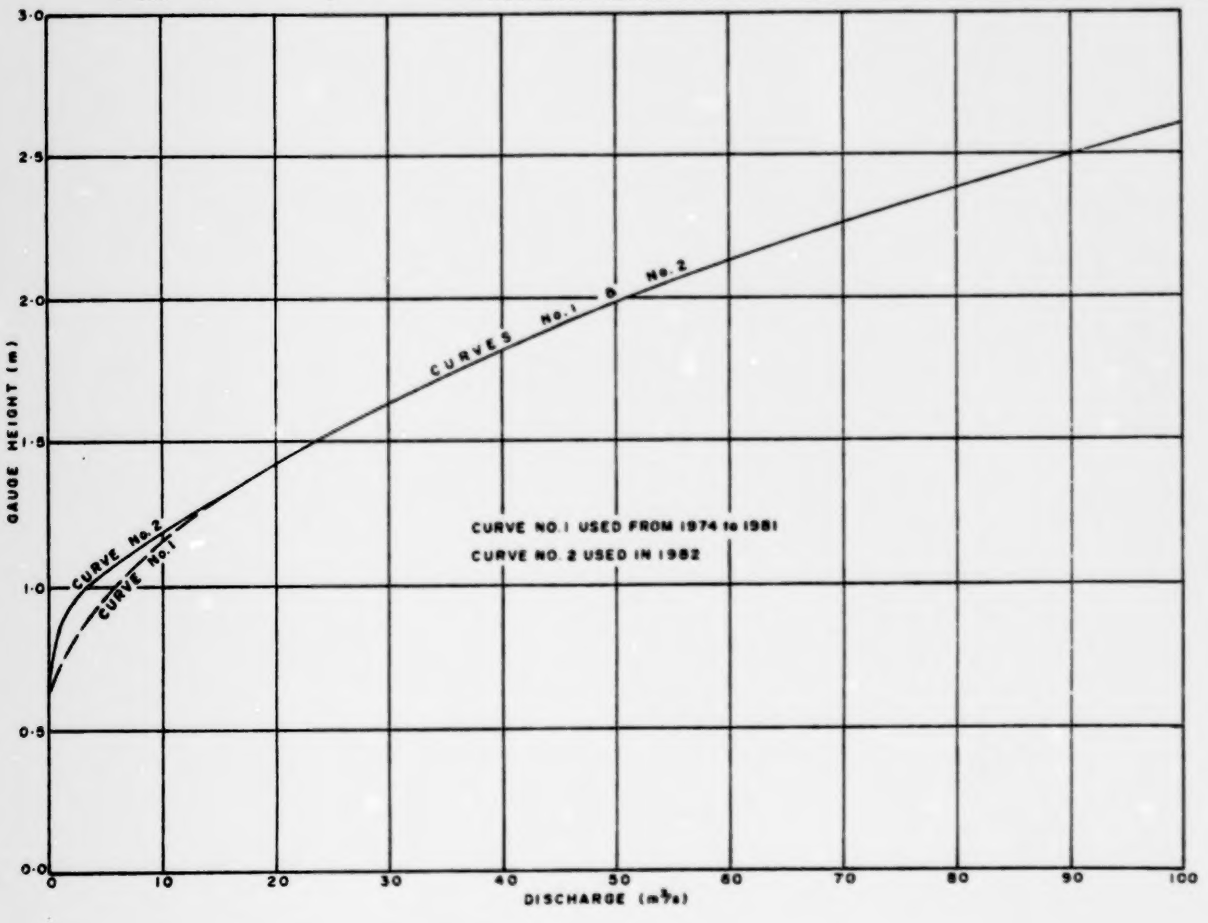


Figure E-2

Stage-Discharge Relationships 1978 to 1982
Milk River near Writing-On-Stone Park

2.2 CROSS-SECTIONS

Plots of the cross-section at the bridge crossing are contained in Figure E-3. These plots are indicative of natural sections in the area as the bridge abutments do not constrict the flow, nor are there any piers. The two cross-sections, August 24, 1978 and May 20, 1982 indicate that there is significant movement of sand dunes through the reach. The main section of the channel shows an infilling of 0.5 metres.

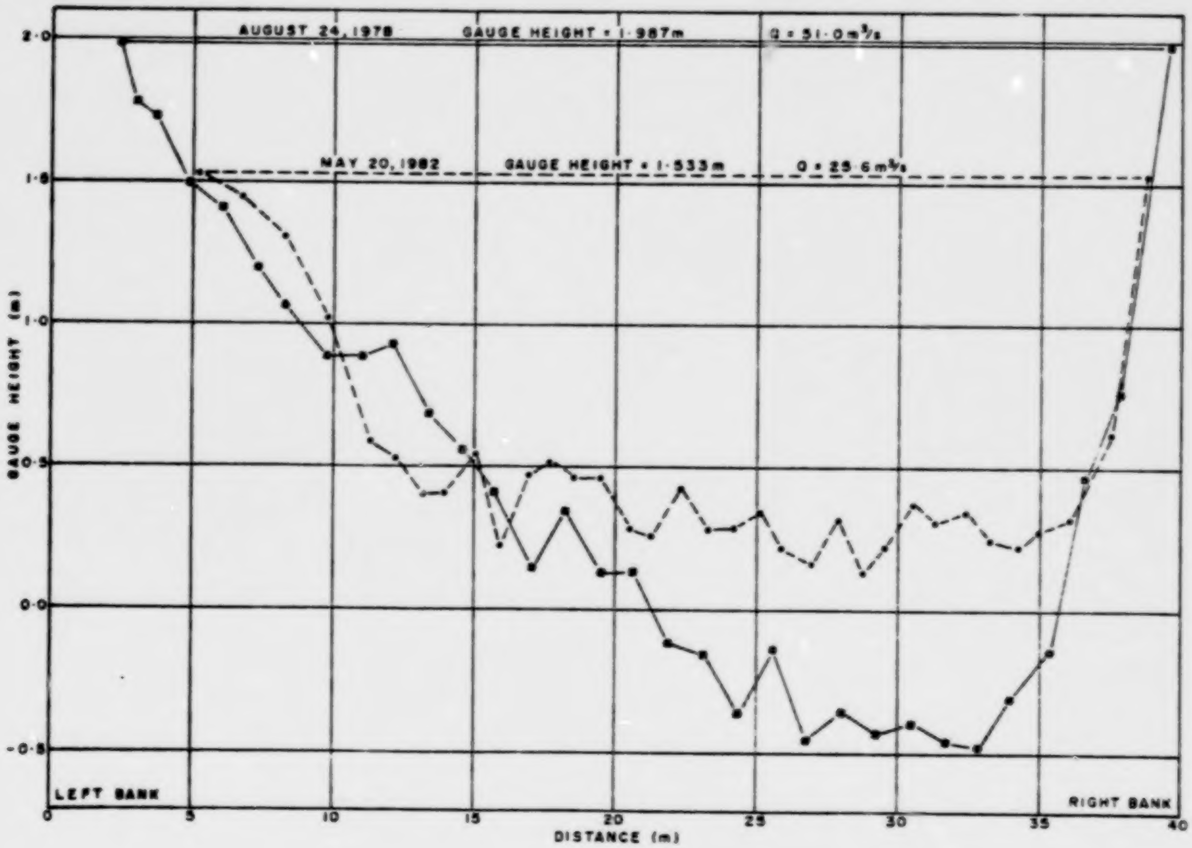


Figure E-3

Cross-Section at Bridge Crossing
Milk River near Writing-On-Stone Park

2.3 SPECIFIC GAUGE DIAGRAM

Insufficient data exists to plot a meaningful specific gauge diagram.

2.4 DISCHARGE VERSUS AREA; MEAN VELOCITY; MEAN DEPTH

Figures E-4 to E-6 contain plots of discharge versus cross-sectional area, discharge versus the mean velocity in the cross-section, and discharge versus mean depth in the cross-section, respectively. The cross-sectional site from which the data was derived is that at the bridge crossing and data were extracted from streamflow discharge measurements made from the bridge. The data used to derive the plots are contained in Table E-2.

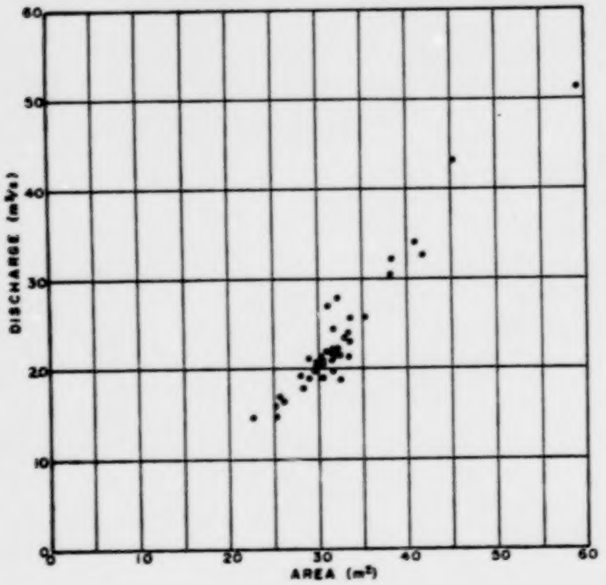


Figure E-4

Discharge versus Cross-Sectional Area

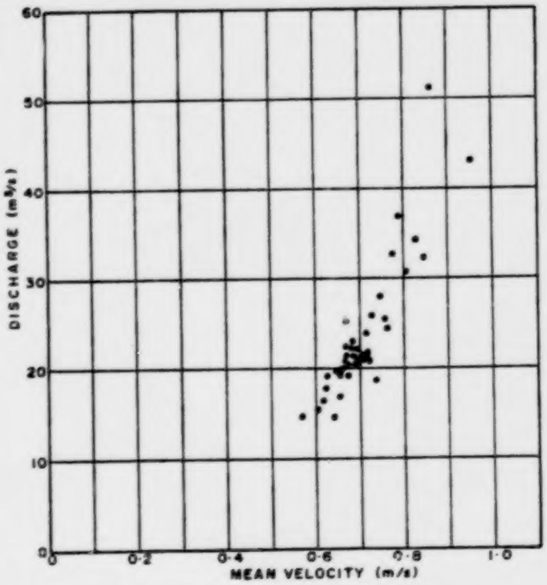


Figure E-5

Discharge versus Mean Velocity

Milk River near Writing-On-Stone Park

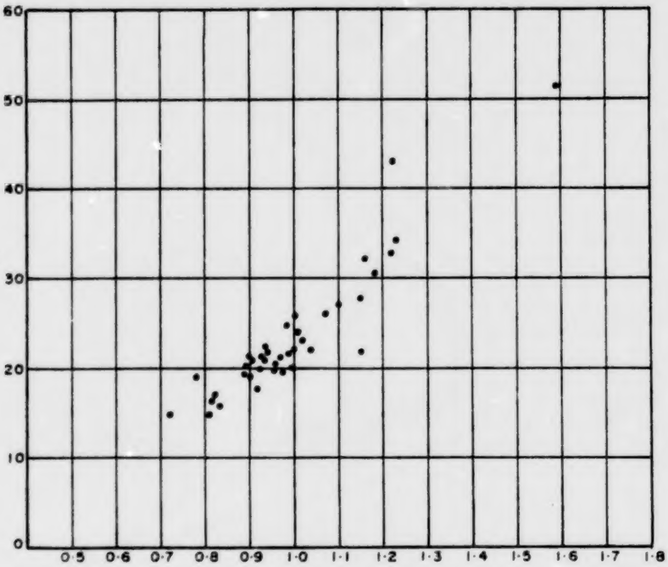


Figure E-6

Discharge Versus Mean Depth
Milk River near Writing-On-Stone Park

TABLE E-2

MILK RIVER NEAR WRITING-ON-STONE PARK

HYDRAULIC DATA AT BRIDGE CROSSING

Date	Discharge	Gauge Height (m)	Mean Velocity (m/s)	Area (m^2)	Width (m)	Mean Depth (m)
1982						
May 20	25.6	1.533	0.762	33.6	33.5	1.00
June 4	21.9	1.463	0.691	31.7	30.5	1.04
July 13	19.6	1.468	0.647	30.3	31.7	0.96
1981						
Apr. 14	18.7	1.393	0.742	25.2	32.5	0.78
May 12	21.7	1.494	0.700	31.0	27.0	1.15
May 26	32.3	1.653	0.846	38.2	33.0	1.16
June 17	32.6	1.662	0.780	41.8	34.4	1.22

TABLE E-2 (cont'd.)

Date	Discharge	Gauge Height (m)	Mean Velocity (m/s)	Area (m^2)	Width (m)	Mean Depth (m)
June 24	24.5	1.582	0.766	32.0	32.5	0.98
June 30	21.7	1.506	0.684	31.7	33.7	0.94
July 14	20.1	1.488	0.672	29.9	30.0	1.00
July 16	20.4	1.504	0.671	30.4	34.1	0.89
July 28	21.3	1.482	0.708	30.1	33.5	0.90
1980						
Apr. 15	43.0	1.886	0.951	45.2	37.0	1.22
Apr. 29	25.8	1.550	0.731	35.3	33.0	1.07
June 3	27.9	1.594	0.748	37.3	32.3	1.15
June 17	26.9	1.551	0.789	34.1	31.0	1.10
July 2	20.9	1.464	0.726	28.8	30.5	0.94
July 17	21.0	1.449	0.714	29.4	31.4	0.94
Aug. 5	20.5	1.451	0.690	29.7	31.0	0.96
1979						
Apr. 11	34.0	1.673	0.829	41.0	33.2	1.23
Apr. 19	30.6	1.597	0.805	38.0	32.3	1.18
May 4	20.9	1.408	0.695	30.0	32.0	0.94
May 16	16.8	1.322	0.658	25.5	31.1	0.82
June 13	23.8	1.500	0.719	33.2	32.9	1.01
June 27	22.0	1.466	0.689	31.9	32.9	1.00
July 17	21.1	1.433	0.701	30.2	31.1	0.97
Aug. 1	21.0	1.408	0.719	29.1	32.3	0.90
Aug. 14	17.6	1.400	0.622	28.3	30.8	0.92
Aug. 30	19.1	1.411	0.628	30.5	31.1	0.98
1978						
June 20	16.2	1.326	0.616	26.2	32.3	0.81
July 4	22.1	1.481	0.683	32.2	34.1	0.94
July 12	23.0	1.469	0.689	33.4	32.6	1.02
July 19	19.7	1.451	0.658	29.9	32.6	0.92
July 24	19.2	1.375	0.677	28.3	31.7	0.89
Aug. 1	15.7	1.335	0.607	25.9	31.1	0.83
Aug. 8	14.7	1.323	0.570	25.8	31.7	0.81
Aug. 16	14.6	1.314	0.643	22.7	31.7	0.72
Aug. 24	51.0	1.987	0.860	59.3	37.2	1.59
Aug. 28	21.5	1.448	0.661	32.5	32.9	0.99
Sept. 6	19.0	1.417	0.652	29.1	32.3	0.90

3.0 SUSPENDED SEDIMENT DATA

3.1 PERIOD OF SAMPLING AND FREQUENCY

A miscellaneous suspended sediment sampling program was conducted during 1981 and 1982. Depth-integrated suspended sediment samples were taken on each visit to the gauging station by the field technician. Table E-3 indicates the number of samples taken each month during 1981 and 1982. Samples were taken at approximately weekly intervals, which is significantly more frequent than most miscellaneous sampling programs which are conducted on an approximate once-a-month frequency. The station had been established as part of a network to define channel losses. Because of channel instability, to more accurately define stream discharge, streamflow measurements were conducted more frequently and as a result, sediment samples were taken at frequent intervals.

TABLE E-3

MILK RIVER NEAR WRITING-ON-STONE PARK

NUMBER OF SUSPENDED SEDIMENT SAMPLES

YEAR	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	TOTAL
1981	-	1	3	8	6	3	6	4*	31
1982	-	1	3	5	3	4	1	3*	20

* - One sample taken in early November.

3.2 SAMPLE LOCATIONS, PROCEDURES AND EQUIPMENT

The depth-integrating sediment samples were not taken at a fixed point from the bridge, but rather, were taken near mid-stream. During the high flow periods (>15 m^3/s) samples were taken from the bridge, using a DH-59 sampler. At lower flows samples were collected by wading to mid-stream, utilizing a DH-48 sampler. No sediment discharge measurements were made to define the lateral variability of the suspended sediment concentration, but it is felt that the miscellaneous samples are an accurate reflection of the average concentration in the cross-section.

3.3 REPRESENTATIVITY

With only five years of flow record and two years of miscellaneous suspended sediment data, neither the flow nor sediment data can be considered to be representative of longer periods. The highest flow at which suspended sediment samples were taken was slightly above 32 m^3/s. The highest recorded flow was 94.9 m^3/s and thus the sediment data does not even cover the range of flows recorded in the short five year period of record.

3.4 SUSPENDED SEDIMENT DISCHARGE DATA

No suspended sediment discharge data have been computed for this site, but pages E-22 to E-24 contain plots of suspended sediment concentration versus streamflow discharge, and pages E-20 and E-21 contain the instantaneous data used to derive these plots. Also included in this Appendix are plots of annual hydrographs for 1981 and 1982 with plotted sample concentrations (page E-19) and a plot of a flow duration curve for the five year flow record with the number of samples at 10% flow intervals indicated in bar graph format (page E-18).

4.0 SUSPENDED SEDIMENT PARTICLE SIZE DATA

Four suspended sediment samples were analyzed for particle size data. These data are contained in Table E-4 and plotted in Figure E-7.

5.0 BED MATERIAL DATA

No bed material samples were taken.

6.0 BED LOAD DISCHARGE

No bed load measurements were made.

7.0 DISSOLVED SOLIDS DATA

Dissolved solids data are a by-product of the laboratory analysis of suspended sediment for either concentration or particle size. These data are presented in tabular form and can be found on page E-20.

TABLE E-4

PARTICLE SIZE ANALYSIS DATA OF DEPTH-INTEGRATED SUSPENDED SEDIMENT SAMPLES

```
WATER SURVEY OF CANADA                 MILK RIVER NEAR WRITING-ON-STONE PARK                                 STATION NO. 11AA036
 09/09/85 , PAGE  1
SEDIMENT SURVEY SECTION               DEPTH INTEGRATING PARTICLE SIZE ANALYSIS OF SUSPENDED SEDIMENT

SAMPLE IDENTIFIER   DISCHARGE    CONC.   PERCENT FINER THAN INDICATED SIZE, IN MICROMETRES  TOTAL          SAND            PERCENT
  DATE        TIME    (M3/S)     (MG/L)     2   4   8  16  31  62 125 250 500 1000 2000   D50   GDG   D50   GDG  CLAY  SILT  SAND

MAY 20 1981  1410       32.5 H   1 210 K   15  25  36  45  57  70  85  95  98   99       22.0  7.4  199.0  1.5   25    45    30
MAY 26 1981  0835       32.3     1 000 K   09  14  22  29  34  46  66  90 100            72.4  6.5  153.4  1.9   14    32    54
MAY 11 1982  1305       20.2 H     723 K   13  20  30  43  52  60  73  83  90   93       25.3  9.9  188.5    *   20    40    40
MAY 19 1982  1625       24.6 H     519 K   15  20  34  48  60  75  90  98  99  100       18.1  6.2  109.9  1.6   20    55    25

DISCHARGE FOOTNOTE SYMBOLS                              CONCENTRATION FOOTNOTE SYMBOLS
    BLANK - INSTANTANEOUS                                   K - SAMPLE(S) COLLECTED IN A SINGLE VERTICAL
        H - DAILY MEAN

                                    GDG (GRADING) = SQUARE ROOT (D84/D16)
                                    * - UNABLE TO COMPUTE DUE TO INSUFFICIENT DATA
```

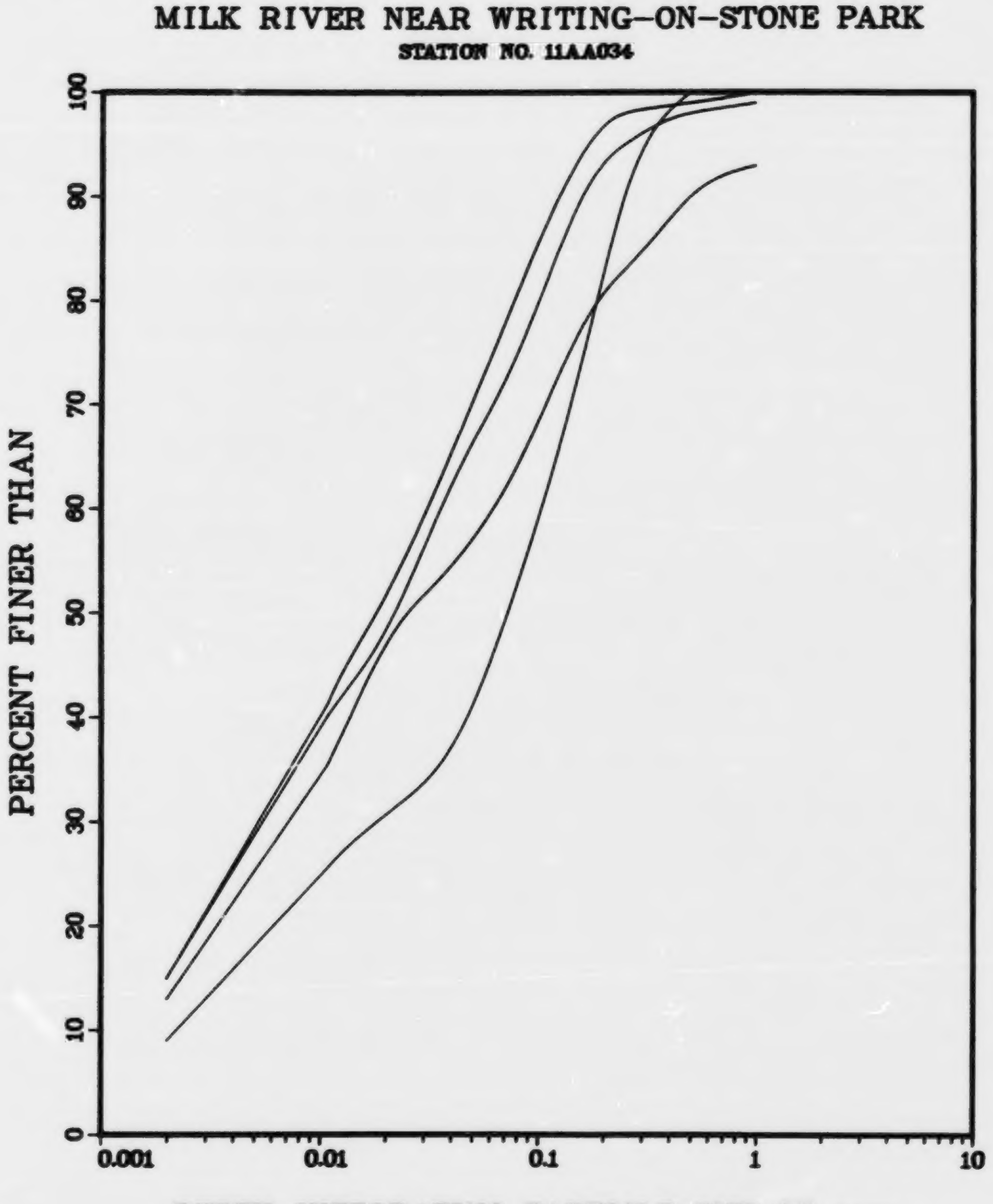


Figure E-7

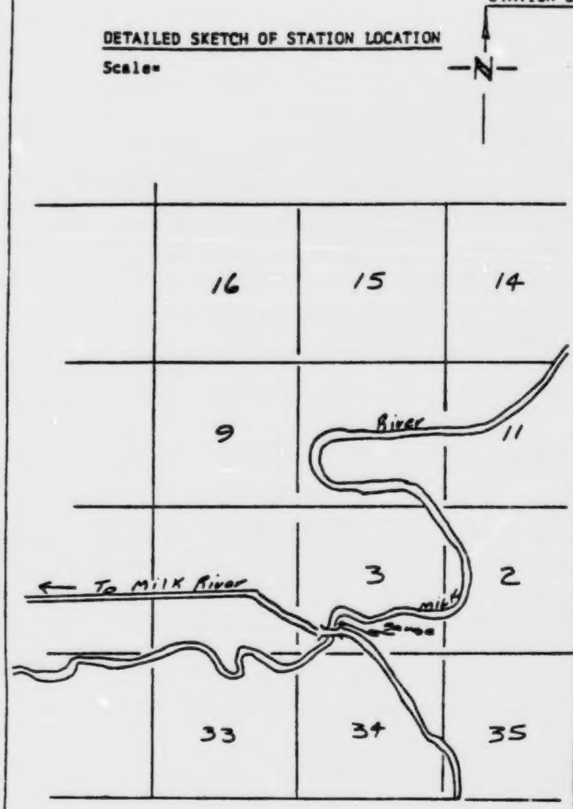
Composite Plot of Particle Size Analysis Data

WATER SURVEY OF CANADA - CALG

STATION DESCRIPTION

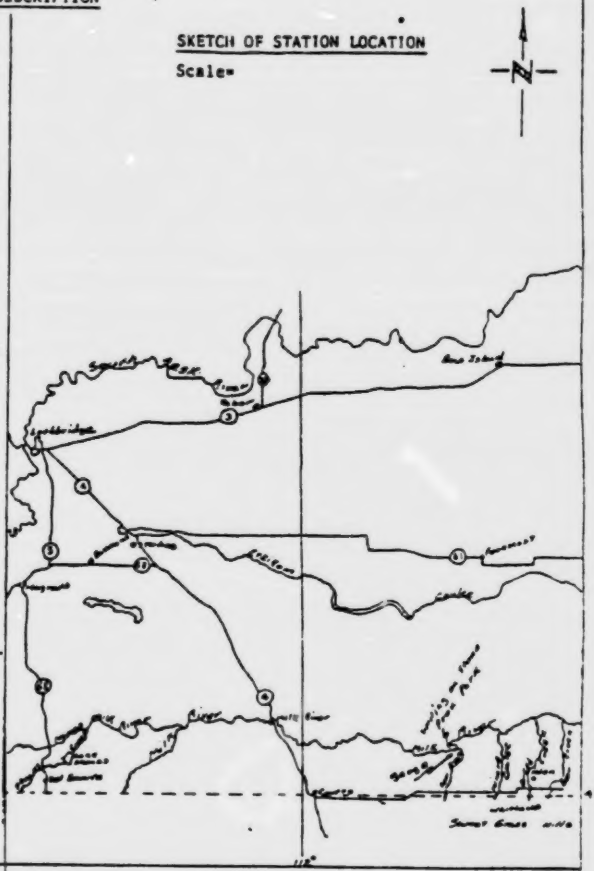
DETAILED SKETCH OF STATION LOCATION

Scale=


N
16
15
14
9
River
11
3
2
← To Milk River
Milk
Gauge
33
34
35

SKETCH OF STATION LOCATION

Scale=


N
Lethbridge
River
Milk River
49°
112°

STATION DESCRIPTION

Station No. 11AA034 Basin

Station Name Milk River near Writing-On-Stone Park

Located in S.W. 1/4 Sec. 3 Tp. 2 Rge. 12 W 4

Latitude 49° 05' 18" Longitude 111° 32' 05"

Established Apr. 1978 by H.M. Wagner

Name of Observer

Address

Rate of Pay Freq. of Obs.

Location of station with respect to towns, etc:

On right bank of river under bridge approx. 6.4 Km. downstream from Writing-On-Stone Park and 48Km. east of Milk River.

Description of gauge and equipment:

0.5 x 3.7m. culvert with California shelter .

Walkway built to shelter

A-35 recorder

W.W.G. mounted on bridge.

Measurement description:

Low measurements are made by wading near the gauge.

High measurements are made from a bridge by the gauge.

Prepared by: J.A. Date: June 14, 1979

BENCH MARKS

Give elevation of bench marks, type, and number or markings, and gauge datum.

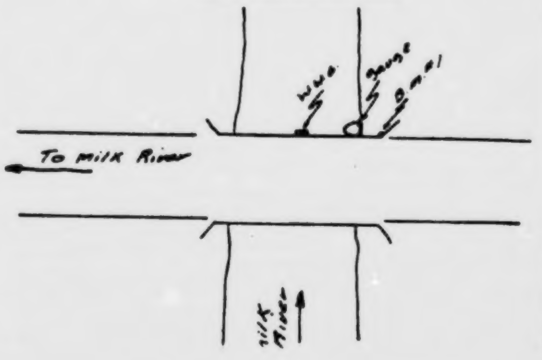
Gauge Datum= 24.975

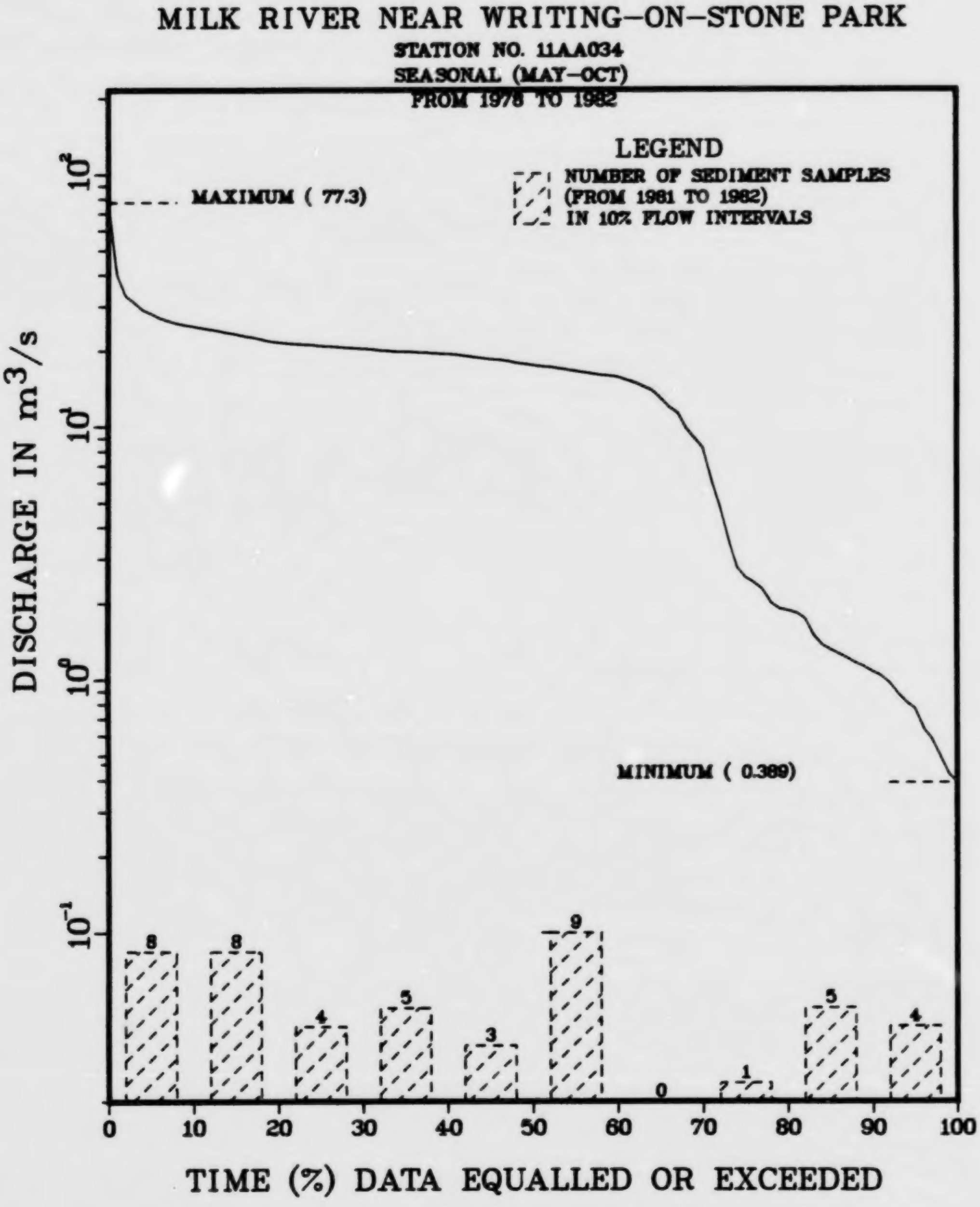
B.M. #1 Head of large bolt in N.E. bedplate of bridge.

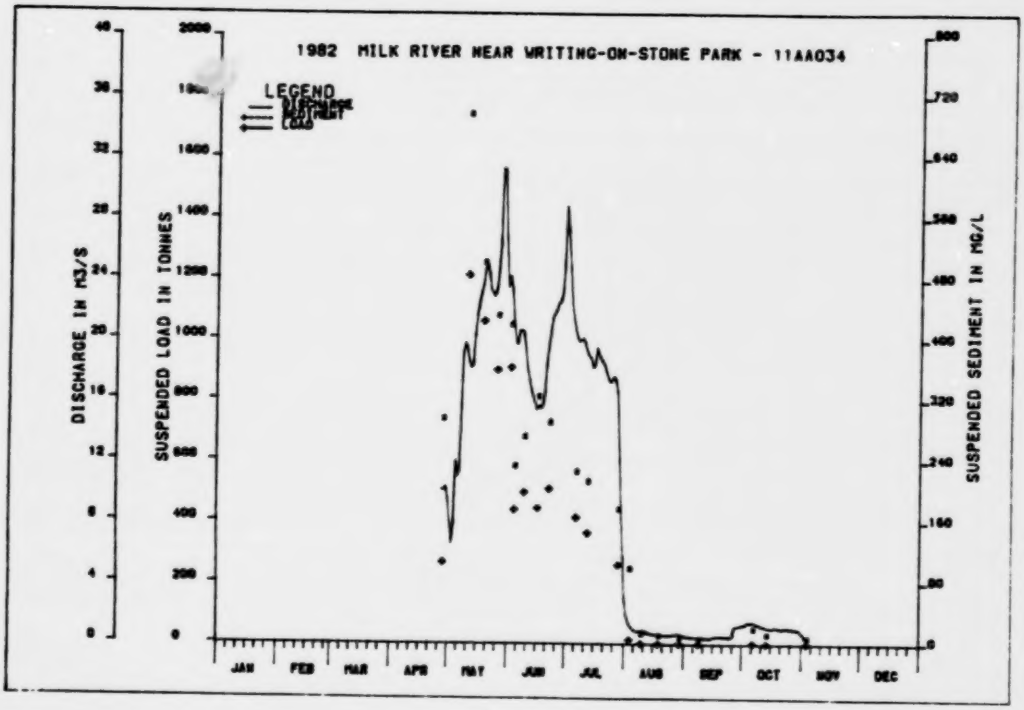
Elevation: 30.480 (assumed)

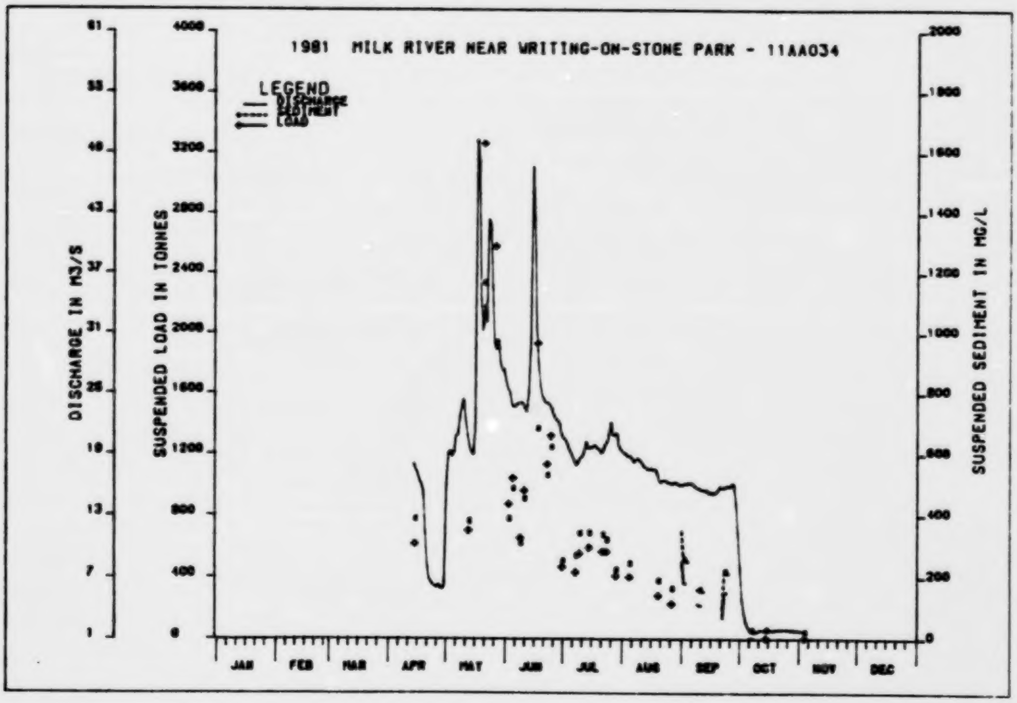
Metric

SKETCH OF BENCH MARKS


W.W.G.
Gauge
B.M.#1
To Milk River
Milk River


MILK RIVER NEAR WRITING-ON-STONE PARK
STATION NO. 11AA034
SEASONAL (MAY-OCT)
FROM 1978 TO 1982
LEGEND
NUMBER OF SEDIMENT SAMPLES
(FROM 1981 TO 1982)
IN 10% FLOW INTERVALS
MAXIMUM (77.3)
MINIMUM (0.389)
DISCHARGE IN m^3/s
10^2
10^1
10^0
10^{-1}
8
8
4
5
3
9
0
1
5
4
0
10
20
30
40
50
60
70
80
90
100
TIME (%) DATA EQUALLED OR EXCEEDED


1982 MILK RIVER NEAR WRITING-ON-STONE PARK - 11AA034
LEGEND
DISCHARGE
SEDIMENT
LOAD
DISCHARGE IN M3/S
0
4
8
12
16
20
24
28
32
36
40
SUSPENDED LOAD IN TONNES
0
200
400
600
800
1000
1200
1400
1600
1800
2000
SUSPENDED SEDIMENT IN MG/L
0
80
160
240
320
400
480
560
640
720
800
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC

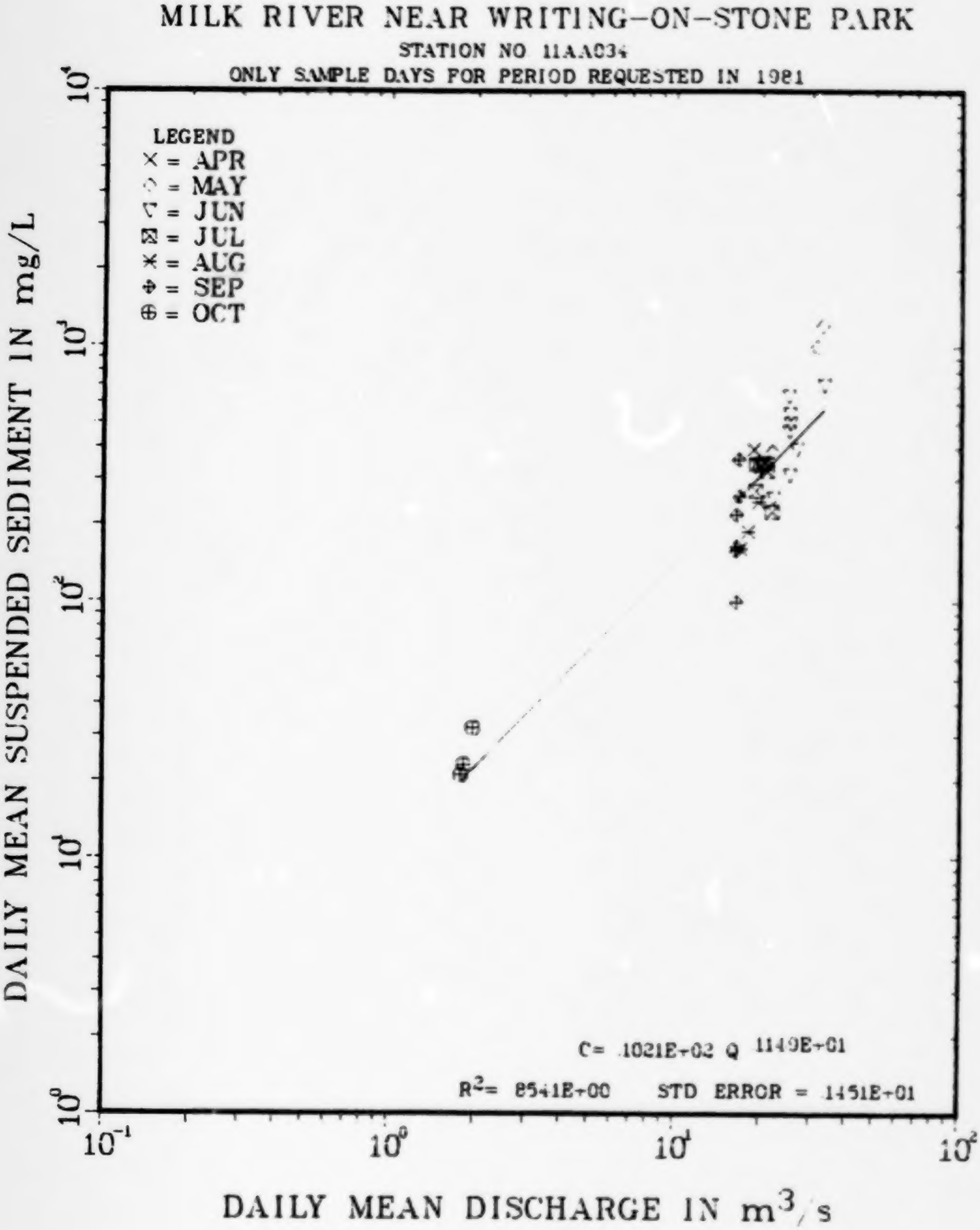

1981 MILK RIVER NEAR WRITING-ON-STONE PARK - 11AA034
LEGEND
DISCHARGE
SEDIMENT
LOAD
DISCHARGE IN M3/S
1
7
13
19
25
31
37
43
49
55
61
SUSPENDED LOAD IN TONNES
0
400
800
1200
1600
2000
2400
2800
3200
3600
4000
SUSPENDED SEDIMENT IN MG/L
0
200
400
600
800
1000
1200
1400
1600
1800
2000
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC

MILK RIVER NEAR WRITING-ON-STONE PARK

MONTH	DAY	TIME	DISSOLVED SOLIDS (mg/L)	INSTANTANEOUS CONCENTRATION (mg/L)	DISCHARGE (m^3/s)
		INSTANTANEOUS DATA FOR 1981			
APR	14	1550	151	397	18.7
MAY	12	1700	221	389	21.7
MAY	20	1510	266	1213	32.4
MAY	26	0955	276	1002	32.3
JUN	2	0920	175	397	26.8
JUN	4	1045	168	501	25.3
JUN	8	1300	147	314	26.6
JUN	10	1320	145	466	25.1
JUN	17	1445	243	706	32.6
JUN	22	1345	160	547	25.0
JUN	24	1305	155	642	24.5
JUN	30	1540	140	255	21.7
JUL	7	1200	131	273	19.2
JUL	9	1115	126	348	19.4
JUL	14	1000	104	350	20.1
JUL	21	1040	131	343	19.8
JUL	23	1225	127	326	20.8
JUL	28	1145	127	226	21.3
AUG	4	0840	114	247	19.7
AUG	19	1245	108	189	18.2
AUG	26	1010	109	162	16.8
SEP	1	0935	114	362	16.6
SEP	2	1015	113	260	16.6
SEP	9	1215	112	165	16.2
SEP	10	1030	110	159	16.1
SEP	22	1115	110	100	16.2
SEP	23	1035	110	220	16.5
OCT	6	1050	244	32	1.98
OCT	7	1035	259	21	1.75
OCT	14	1130	333	23	1.86
NOV	3	1000	395	15	1.76
		INSTANTANEOUS DATA FOR 1982			
APR	28	1245	263	304	11.8
MAY	11	1305	206	723	20.1
MAY	19	1625	177	519	24.6
MAY	26	1340	175	446	24.1
JUN	2	0850	301	434	26.0
JUN	4	1315	246	240	21.9

MILK RIVER NEAR WRITING-ON-STONE PARK

MONTH	DAY	TIME	DISSOLVED SOLIDS (mg/L)	INSTANTANEOUS CONCENTRATION (mg/L)	DISCHARGE (m^3/s)
		INSTANTANEOUS DATA FOR 1982 (cont'd.)			
JUN	9	1100	243	281	21.4
JUN	16	0940	185	335	15.9
JUN	22	0955	160	300	17.9
JUL	6	1515	149	232	21.4
JUL	12	1600	148	219	20.0
JUL	28	1610	107	181	17.3
AUG	3	1420	209	100	1.49
AUG	9	1400	350	11	0.868
AUG	18	0920	439	8	0.657
AUG	29	1145	501	6	0.645
SEP	8	0912	529	4	0.410
OCT	6	0900	471	18	1.52
OCT	13	0920	456	10	1.20
NOV	3	1030	509	5	0.298



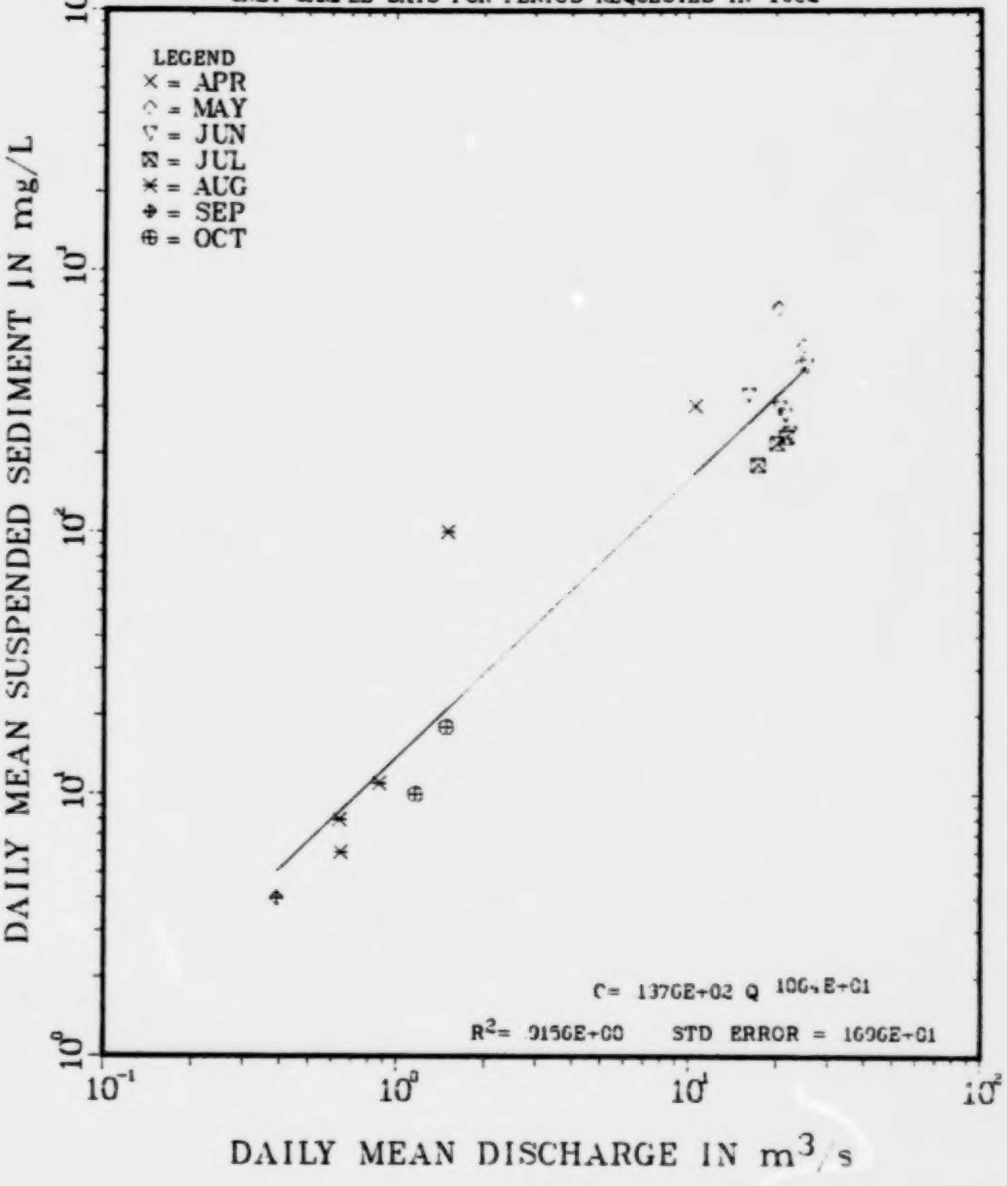
MILK RIVER NEAR WRITING-ON-STONE PARK

STATION NO 11AA034

ONLY SAMPLE DAYS FOR PERIOD REQUESTED IN 1981

MILK RIVER NEAR WRITING-ON-STONE PARK

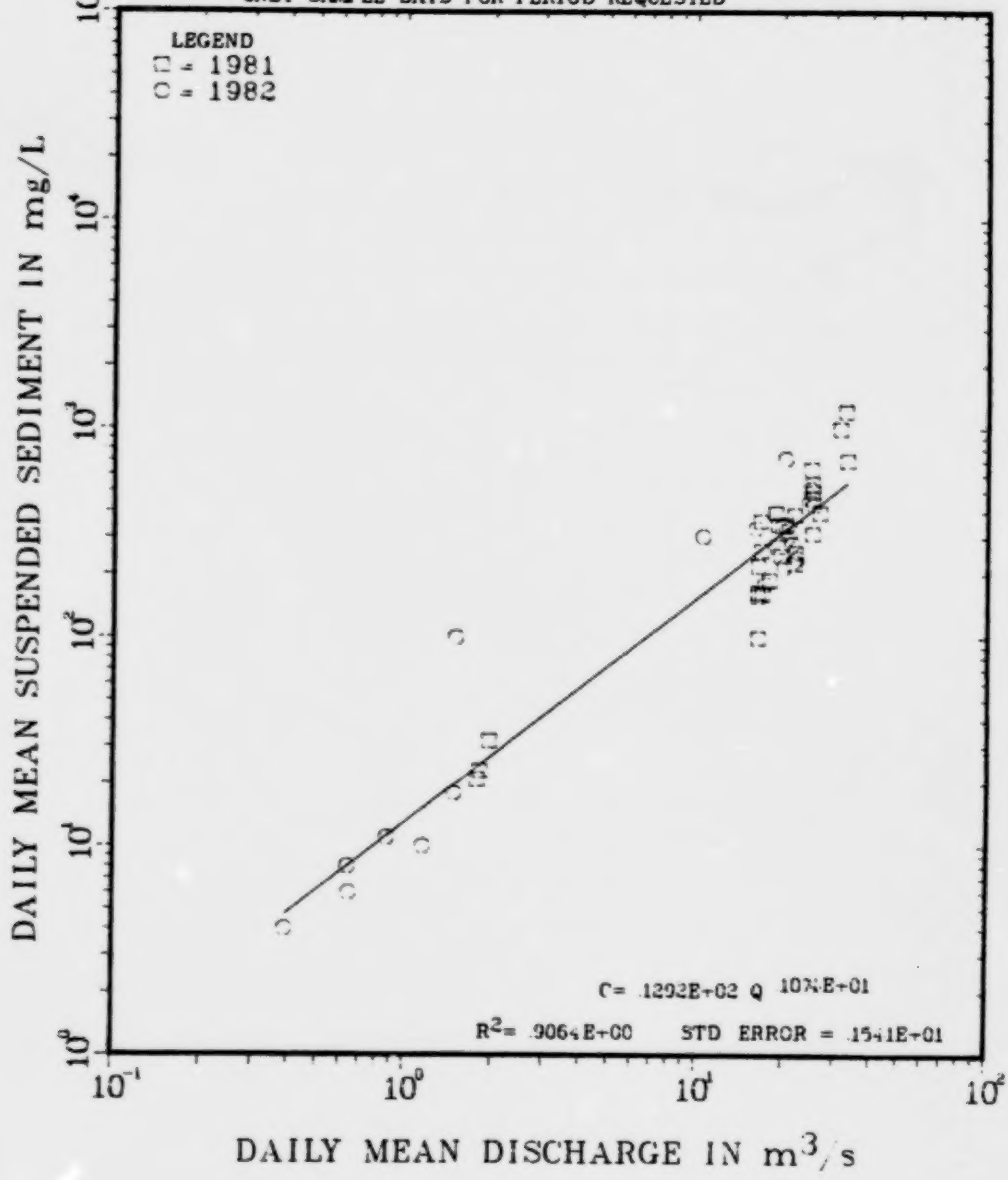
STATION NO. 11AA034
ONLY SAMPLE DAYS FOR PERIOD REQUESTED IN 1982



MILK RIVER NEAR WRITING-ON-STONE PARK

STATION NO. 11AA034

ONLY SAMPLE DAYS FOR PERIOD REQUESTED



APPENDIX F

MILK RIVER NEAR PENDANT D'OREILLE

11AA035

TABLE OF CONTENTS

MILK RIVER NEAR PENDANT D'OREILLE

Page

1.0 HYDROMETRIC STATION DESCRIPTION F-4

1.1 Period of Record F-4
1.2 Gauging Station Description F-4
1.3 Channel and Valley Features F-4
Table F-1: River Valley, Flat and Channel Features F-5
1.4 Stereo Pair F-6
Figure F-1: Stereo Pair Aerial Photograph F-6
1.5 On Site Photographs F-6

2.0 HYDRAULIC DATA F-8

2.1 Rating Curve F-8
Figure F-2: Stage Discharge-Relation F-8
2.2 Cross-Section F-8
Figure F-3: Cross-Section Under Cableway F-9
2.3 Specific Gauge Diagram F-9
2.4 Discharge versus Area; Mean Velocity; Mean Depth F-9
Figure F-4: Discharge versus Area F-10
Figure F-5: Discharge versus Mean Velocity F-10
Figure F-6: Discharge versus Mean Depth F-11
Table F-2: Hydraulic Data at Cableway F-12

3.0 SUSPENDED SEDIMENT DATA F-14

3.1 Period of Sampling and Frequency F-14
Table F-3: Number of Suspended Sediment Samples F-14
3.2 Sampling Location, Procedures and Equipment F-14
3.3 Representativity F-15

4.0 SUSPENDED SEDIMENT PARTICLE SIZE DATA F-15

Table F-4: Particle Size Data of Suspended Sediment Samples F-15
Figure F-7: Composite Plot of Particle Size Analysis Data F-16
Figure F-8: Particle Size Statistics Compared to Streamflow Discharge F-17
Figure F-9: Percentage of Silt and Clay as a Function of Concentration and Discharge F-18
Figure F-10: Particle Size Statistics for Sand Component Compared to Streamflow Discharge F-19
Figure F-11: Variation of Concentration with Discharge Showing the Sand Component of the Suspended Sediments F-20

TABLE OF CONTENTS

MILK RIVER NEAR PENDANT D'OREILLE

Page

5.0 BED MATERIAL DATA F-21

6.0 BED LOAD DISCHARGE DATA F-21

7.0 DISSOLVED SOLIDS DATA F-21

DIAGRAMS AND TABLES OF DATA F-22

- Station Description F-22
- Flow Duration Curve F-23
- Streamflow and Sediment Hydrographs F-24
- Instantaneous Suspended Sediment Data F-25
- Annual Suspended Sediment Rating Curves F-27

MILK RIVER NEAR PENDANT D'OREILLE: 11AA035

1.0 HYDROMETRIC STATION DESCRIPTION

1.1 PERIOD OF RECORD

This gauging station was established in May 1978 and was operated on a May to October basis through, and inclusive, to 1982. This station was established primarily to assist in a streamflow channel loss study, but its operation coincided with the sediment study being conducted along the Milk River system and hence it was included in the program. Suspended sediment data were collected in 1981 and 1982.

1.2 GAUGING STATION DESCRIPTION

This gauging station was located on the left bank side and consisted of a Servo manometer-driven A-71 Stevens strip chart recorder, housed in a standard walk-in shelter.

Low to moderate flows were metered by wading in the vicinity of the gauge, while higher discharge measurements (>15 m^3/s) were conducted from a cableway which spanned the river 30 metres above the gauge.

A copy of the fieldman's station description can be found on page F-22.

1.3 CHANNEL AND VALLEY FEATURES

The gauging station is located in a badlands type terrain. The significant features of the valley and river are listed in Table F-1. These features are derived from aerial photograph interpretation. The classification of features are based on Kellerhals et al (1976).

TABLE F-1

MILK RIVER NEAR PENDANT D'OREILLE

RIVER VALLEY, VALLEY FLAT AND CHANNEL FEATURES

GENERAL DESCRIPTION IN VINCITY OF HYDROMETRIC STATION (ABOVE VALLEY)

Terrain : Plains with Localized Badlands
Vegetation : Grass
Land Use : No Cultivation

VALLEY CHARACTERISTICS ABOVE VALLEY FLAT

Slumping of Valley Walls : Occasional
Vegetation on Valley Walls : Almost None

TERRACES

Presence : Fragmentary
Number of Levels : Several

RELATION OF CHANNEL TO VALLEY

Valley Type : Stream Cut Valley
Relation of Channel to Valley Bottom: Partly entrenched.
Relation of Channel to Valley Walls or to Resistant Terraces : Confined

DESCRIPTION OF VALLEY FLAT

Presence : Fragmentary
Extent : Moderate (1 to 5 water surface widths)
Vegetation : Grass and Shrubs

CHANNEL DESCRIPTION

Pattern : Irregular Meanders
Islands : Occasional (sand bars)
Bar Type : Point, Side and Mid-Channel
Type of Flow : Uniform Water Surface

LATERAL CHANNEL ACTIVITY

Lateral Activity : Downstream progression
Lateral Stability : Moderately Unstable

CHANNEL BANK AND BEDS

Alluvial Bank Material : Silt and Sand
Predominant Bed Material : Sand

1.4 STEREO PAIR

Figure F-1 is a stero pair of the gauging station site. The photographs were taken in July 1974 and the scale is 1:31 680.

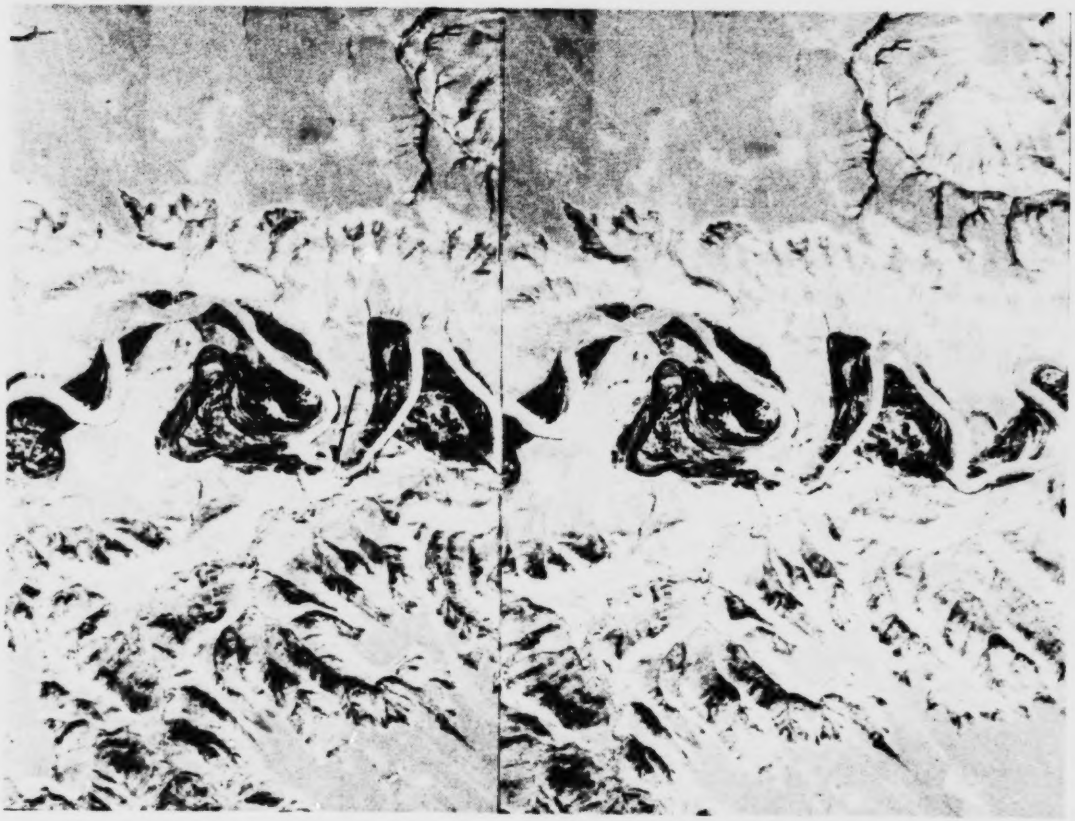
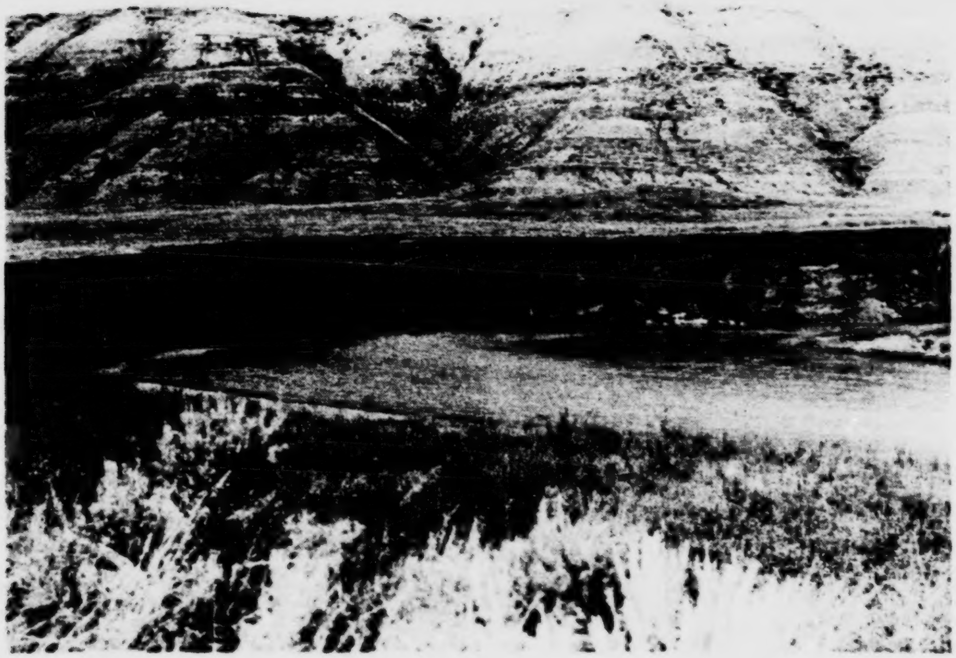


Figure F-1

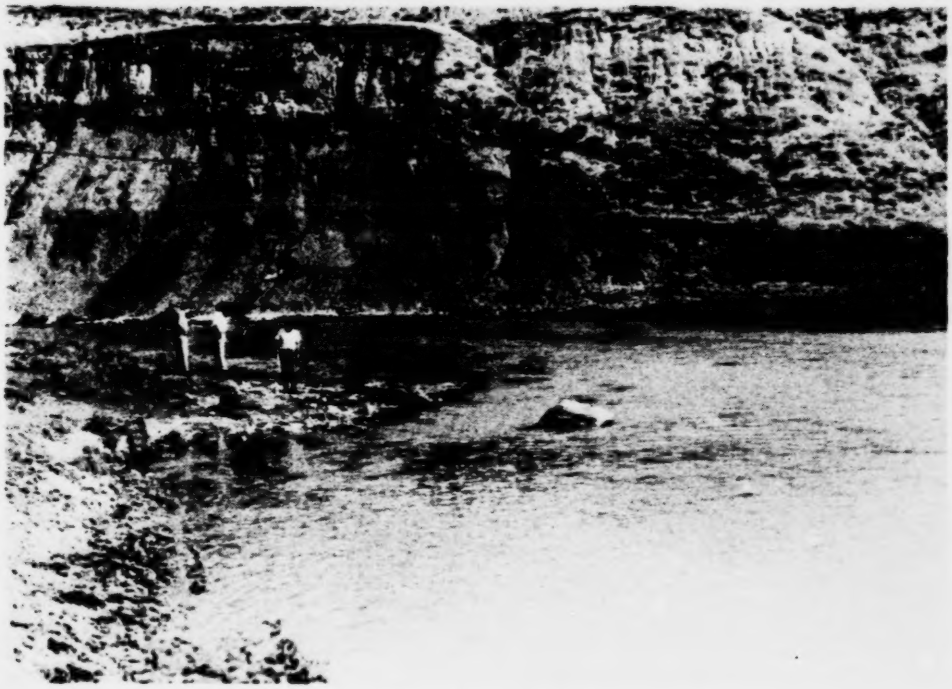
Stereo Pair Aerial Photographs
Arrow Indicates Gauging Station Location
Milk River near Pendant D'Oreille

1.5 ON SITE PHOTOGRAPHS

500m below former gauge site looking upstream.



450m below former gauge site looking downstream.
(note slumping banks)



At former gauge site, looking downstream

At former gauge site, looking downstream.

2.0 HYDRAULIC DATA

2.1 RATING CURVE

The stage-discharge relation for this station is depicted in Figure F-2. Only one relation was used for the five years of record but, because of dune movement through the reach, streamflow measurement gauge heights had a scatter of plus or minus one decimetre about the curve.

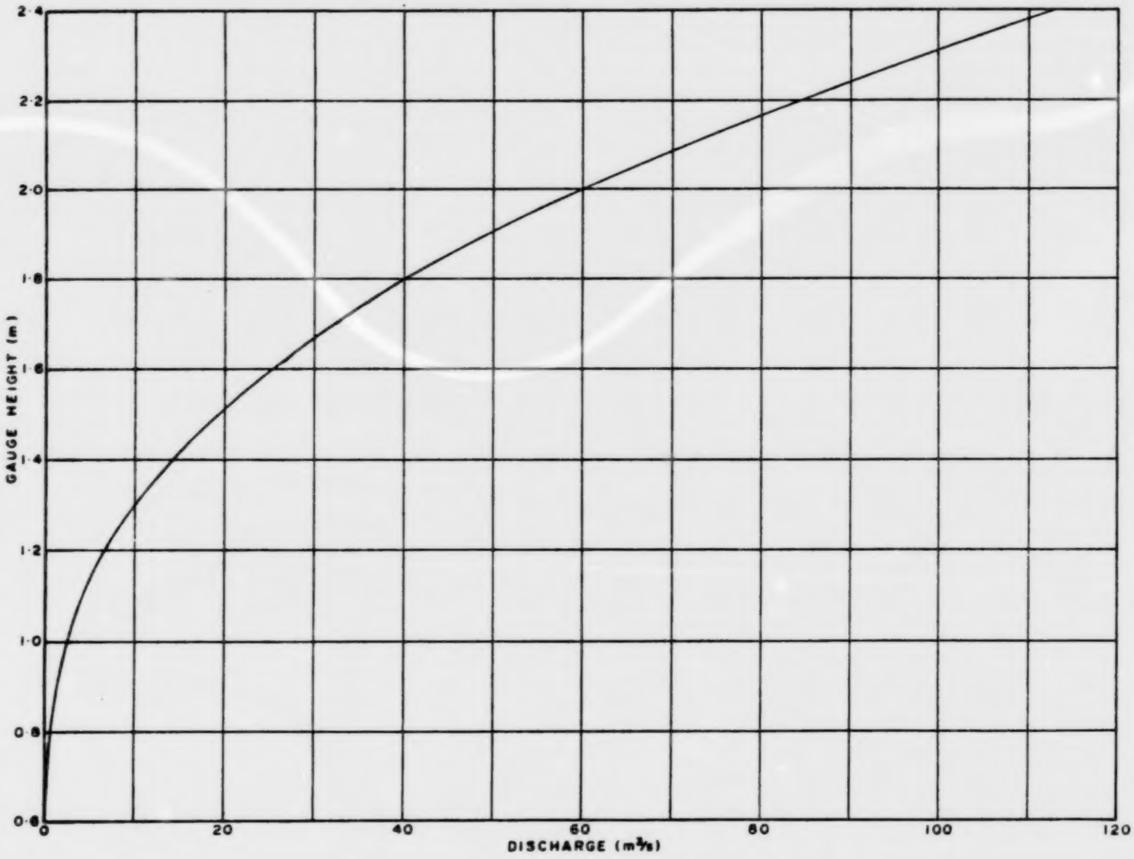


Figure F-2

Stage Discharge Relation: 1978 to 1982
Milk River near Pendant D'Oreille

2.2 CROSS-SECTIONS

The cross-section at the cableway crossing is depicted in Figure F-3. Two cross-sections were plotted, one from a measurement made on

August 24, 1978 and the other from a measurement of June 16, 1982. The superimposition of these cross-sections points out the changes in the stream bed due to dune progression, further lending credence to the scatter of discharge measurements about the stage-dishcarge relationship.

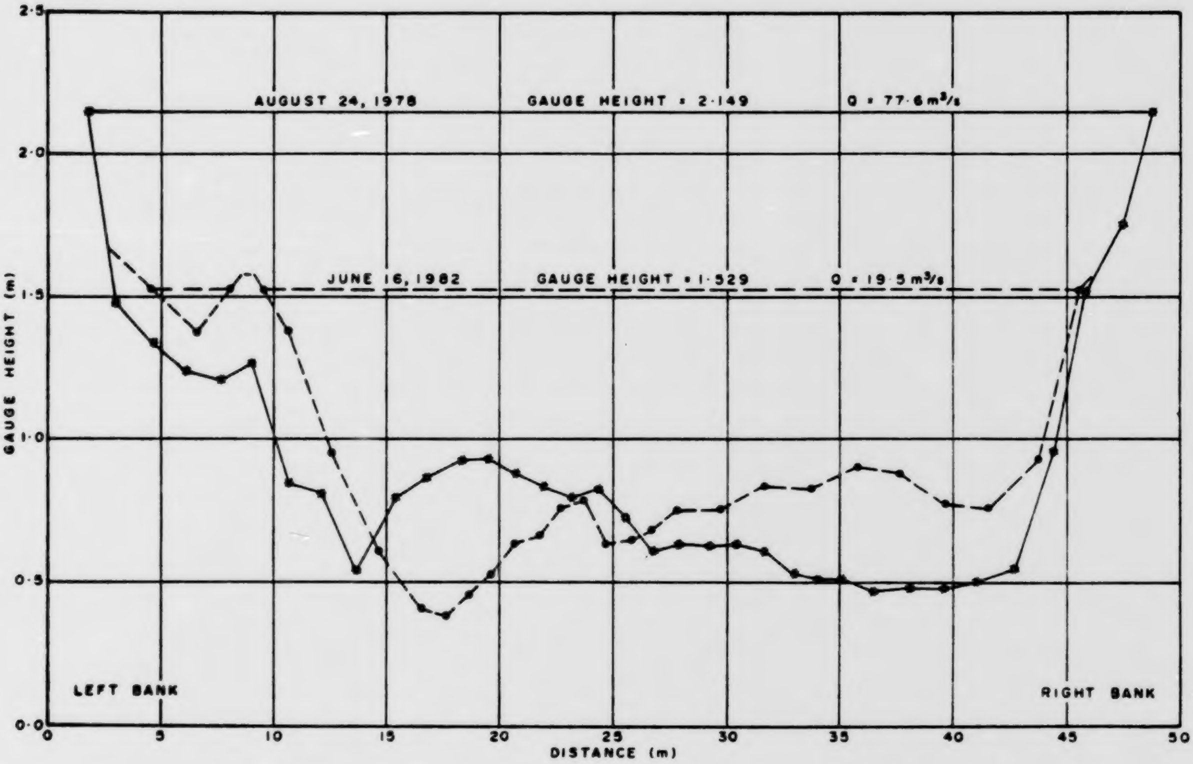


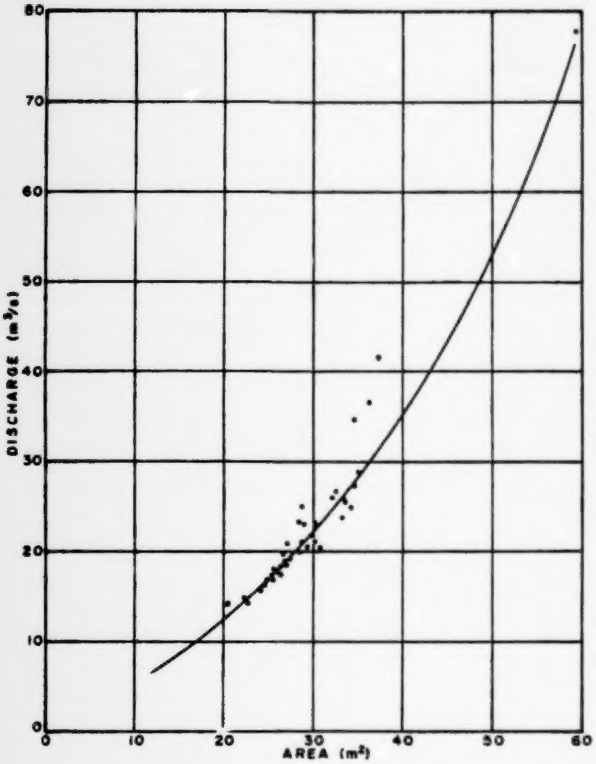
Figure F-3
Cross-Section Under Cableway
Milk River near Pendant D'Oreille

2.3 SPECIFIC GAUGE DIAGRAM

Insufficient data exists to plot a meaningful specific gauge diagram.

2.4 DISCHARGE VERSUS AREA; MEAN VELOCITY; AND MEAN DEPTH

Figures F-4 to F-6 are plots of relations between discharge versus cross-sectional area, discharge versus mean velocity in the cross-section, and discharge versus mean depth in the cross-section, respectively. The site from which the data was derived is that directly below the cableway and data were extracted from streamflow discharge measurements made from the cableway. The data used in the plots have been tabulated and are contained in Table F-2.



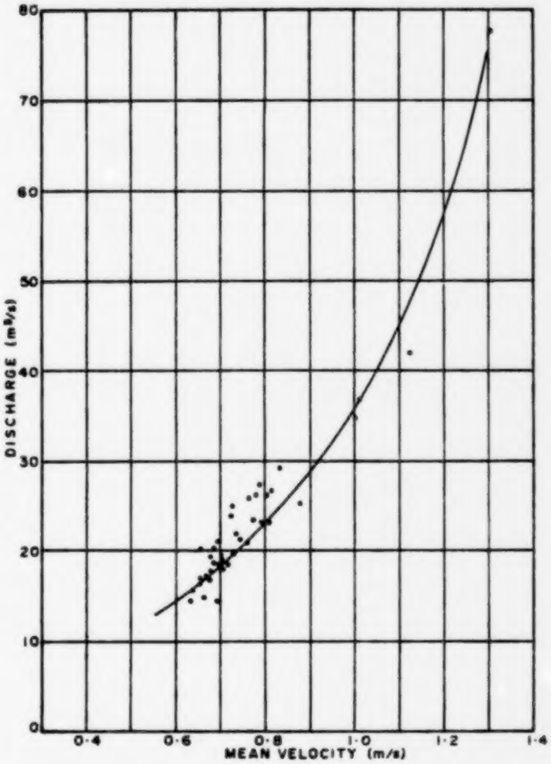


Figure F-4

Discharge versus Cross-Sectional Area

Figure F-5

Discharge versus Mean Velocity

Milk River near Pendant D'Oreille

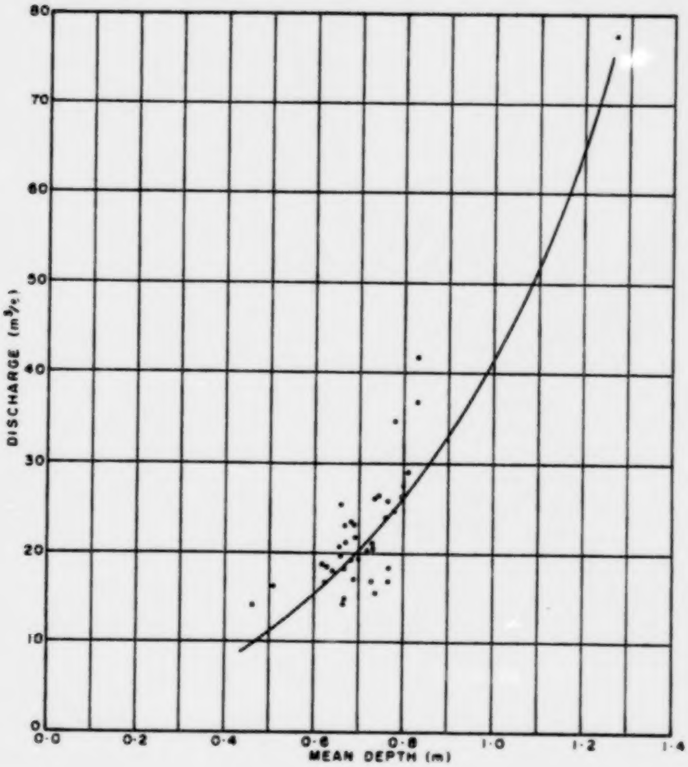


Figure F-6

Discharge Versus Mean Depth
Milk River near Pendant D'Oreille

TABLE F-2

HYDRAULIC DATA AT CABLEWAY LOCATION MILK RIVER NEAR PENDANT D'OREILLE

Date	Discharge	Gauge Height (m)	Mean Velocity (m/s)	Area (m^2)	Width (m)	Mean Depth (m)
1982						
May 20	23.1	1.599	0.794	29.1	42.0	0.69
June 3	29.1	1.780	0.829	35.1	43.5	0.81
June 16	19.5	1.529	0.730	26.7	40.5	0.66
July 13	19.3	1.578	0.677	28.5	41.0	0.70
July 28	18.3	1.535	0.693	26.4	34.5	0.77
1981						
Apr. 14	16.7	1.540	0.673	24.8	40.0	0.62
May 1	23.9	1.692	0.722	33.1	43.5	0.76
May 26	36.8	1.855	1.011	36.4	44.0	0.83
June 17	41.9	1.839	1.130	37.2	45.0	0.83
June 24	21.0	1.658	0.691	30.4	41.5	0.73
June 30	21.7	1.640	0.734	29.6	43.0	0.69
July 9	19.2	1.602	0.701	27.4	40.1	0.68
July 15	20.6	1.606	0.760	27.1	41.0	0.66
July 21	20.3	1.632	0.690	29.4	41.0	0.72
Sept.29	16.2	1.529	0.653	24.8	48.2	0.51
1980						
Apr. 15	14.18	1.480	0.698	20.2	44.0	0.46
Apr. 16	34.9	1.758	1.00	34.8	44.5	0.78
Apr. 29	24.8	1.730	0.721	34.4	43.9	0.78
June 4	27.4	1.765	0.787	34.8	43.3	0.80
June 17	26.5	1.806	0.813	32.6	43.3	0.75
July 1	21.2	1.665	0.741	28.6	43.0	0.67
July 17	18.0	1.590	0.706	25.5	40.0	0.64
1979						
Apr. 18	25.4	1.585	0.881	28.9	43.9	0.66
May 3	23.2	1.625	0.808	28.8	43.3	0.67
May 16	18.8	1.554	0.704	26.7	43.3	0.62
June 12	23.3	1.673	0.774	30.1	43.9	0.69
June 27	20.4	1.655	0.658	31.0	42.7	0.73
July 18	18.5	1.582	0.689	26.9	42.7	0.63
Aug. 1	18.2	1.615	0.713	25.5	37.8	0.67
Aug. 13	16.8	1.439	0.652	25.8	33.5	0.77
Aug. 29	17.0	1.573	0.668	25.5	37.2	0.69

TABLE F-2 (cont'd.)

Date	Discharge	Gauge Height (m)	Mean Velocity (m/s)	Area (m^2)	Width (m)	Mean Depth (m)
1978						
June 20	14.8	1.390	0.664	22.3	33.2	0.67
July 4	26.0	1.606	0.802	32.4	43.9	0.74
July 11	26.0	1.658	0.777	33.4	41.5	0.80
July 19	25.8	1.682	0.768	33.5	43.6	0.77
July 25	17.6	1.472	0.680	26.0	35.4	0.73
Aug. 1	15.5	1.402	0.640	24.3	32.9	0.74
Aug. 8	14.3	1.420	0.634	22.6	33.5	0.67
Aug. 24	77.6	2.149	0.301	59.6	46.9	1.27

3.0 SUSPENDED SEDIMENT DATA

3.1 PERIOD OF SAMPLING AND FREQUENCY

A miscellaneous suspended sediment sampling program was conducted during 1981 and 1982. Depth-integrated suspended sediment samples were taken on each visit to the gauging station by the field technician. Table F-3 indicates the number of samples taken each month. From June through October, samples were taken at a frequency of approximately one to two per week, which is much more frequent than normal miscellaneous programs (one per month), but the gauging station had been established as an integral part of a channel loss study and therefore, because of channel instability, streamflow discharge measurements were performed often and, propitiously, miscellaneous suspended sediment samples were taken concurrently.

TABLE F-3

MILK RIVER NEAR PENDANT D'OREILLE

NUMBER OF SUSPENDED SEDIMENT SAMPLES

YEAR	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	TOTAL
1981	-	2	3	8	7	4	6	4*	34
1982	-	1	2	4	3	7	1	3*	21

* - One sample taken in early November.

3.2 SAMPLE LOCATIONS, PROCEDURES AND EQUIPMENT

Depth-integrating suspended sediment samples were not taken from a fixed point in the cross-section, but rather, were taken near mid-stream. During high flow periods (>15 m^3/s) samples were taken from the cableway, utilizing a DH-59 sampler. At lower flows, samples were obtained by wading to mid-stream below the cableway, sampling with a DH-48 sampler. No sediment discharge measurements were made to define the variation of concentration across the cross-section, but it is anticipated that the concentration is fairly homogenous, and therefore the miscellaneous samples are felt to be a good indication of average concentration in the cross-section.

3.3 REPRESENTATIVITY

With only two years of suspended sediment data and five years of flow data, neither flow nor sediment data can be said to be representative of long-term data. The highest flow at which a sediment sample was taken was 40 m^3/s, whereas the highest flow recorded in the five year period of streamflow record was 104 m^3/s. Therefore, the samples do not cover even the range in flows over the short term.

4.0 SUSPENDED SEDIMENT PARTICLE SIZE DATA

A total of seven suspended sediment samples were analyzed for particle size information. The data are contained in Table F-4 and are plotted in Figure F-7.

TABLE F-4

PARTICLE SIZE ANALYSIS DATA OF DEPTH-INTEGRATED SUSPENDED SEDIMENT SAMPLES

```
WATER SURVEY OF CANADA                 MILK RIVER NEAR PENDANT D'OREILLE                                         STATION NO. 11AA039
 09/09/85 , PAGE  1
SEDIMENT SURVEY SECTION              DEPTH INTEGRATING PARTICLE SIZE ANALYSIS OF SUSPENDED SEDIMENT

SAMPLE IDENTIFIER   DISCHARGE    CONC.   PERCENT FINER THAN INDICATED SIZE, IN MICROMETRES  TOTAL        SAND          PERCENT
   DATE      TIME     (M3/S)     (MG/L)     2    4    8   16   31   62 125 250 500 1000 2000   D50   GDG    D50   GDG  CLAY  SILT  SAND

MAY 20 1981  1215      38.9 M   1 860 K    15   24   35   48   60   78  92  98 100            17.7  5.9   98.4  1.7   24    54    22
MAY 26 1981  1200      36.8     1 720 K    13   20   26   33   39   54  78  96  99  100       54.6  7.3  121.4  1.8   20    34    46
JUN 17 1981  1035      41.9     2 680 K    17   26   36   46   55   69  83  98 100            21.3    *   135.2  1.7   26    43    31
JUL  7 1981  1045      22.7 M   1 460 K    32   41   52   63   73   81  92  99 100             7.0    *   115.1  1.5   41    40    19
MAY 19 1982  1940      24.4 M     958 K    16   21   30   42   59   72  92  99 100            24.3  6.8   99.6  1.4   21    51    28
MAY 26 1982  0950      25.7 M     715 K    15   20   29   41   54   70  89  97  99   99       29.5  6.6  107.3  1.5   20    50    30
JUN  3 1982  1445      29.1     1 900 K    06   08   11   14   19   27  48  87 100           130.4  3.3  167.7  1.6    8    19    73

DISCHARGE FOOTNOTE SYMBOLS                              CONCENTRATION FOOTNOTE SYMBOLS
    BLANK - INSTANTANEOUS                                   K - SAMPLE(S) COLLECTED IN A SINGLE VERTICAL
        M - DAILY MEAN

                                   GDG (GRADING) = SQUARE ROOT (D84/D16)
                                   * - UNABLE TO COMPUTE DUE TO INSUFFICIENT DATA
```

Figures F-8 to F-11 are a further graphical rendering of particle size data, but the number of samples are insufficient to discern any trends.

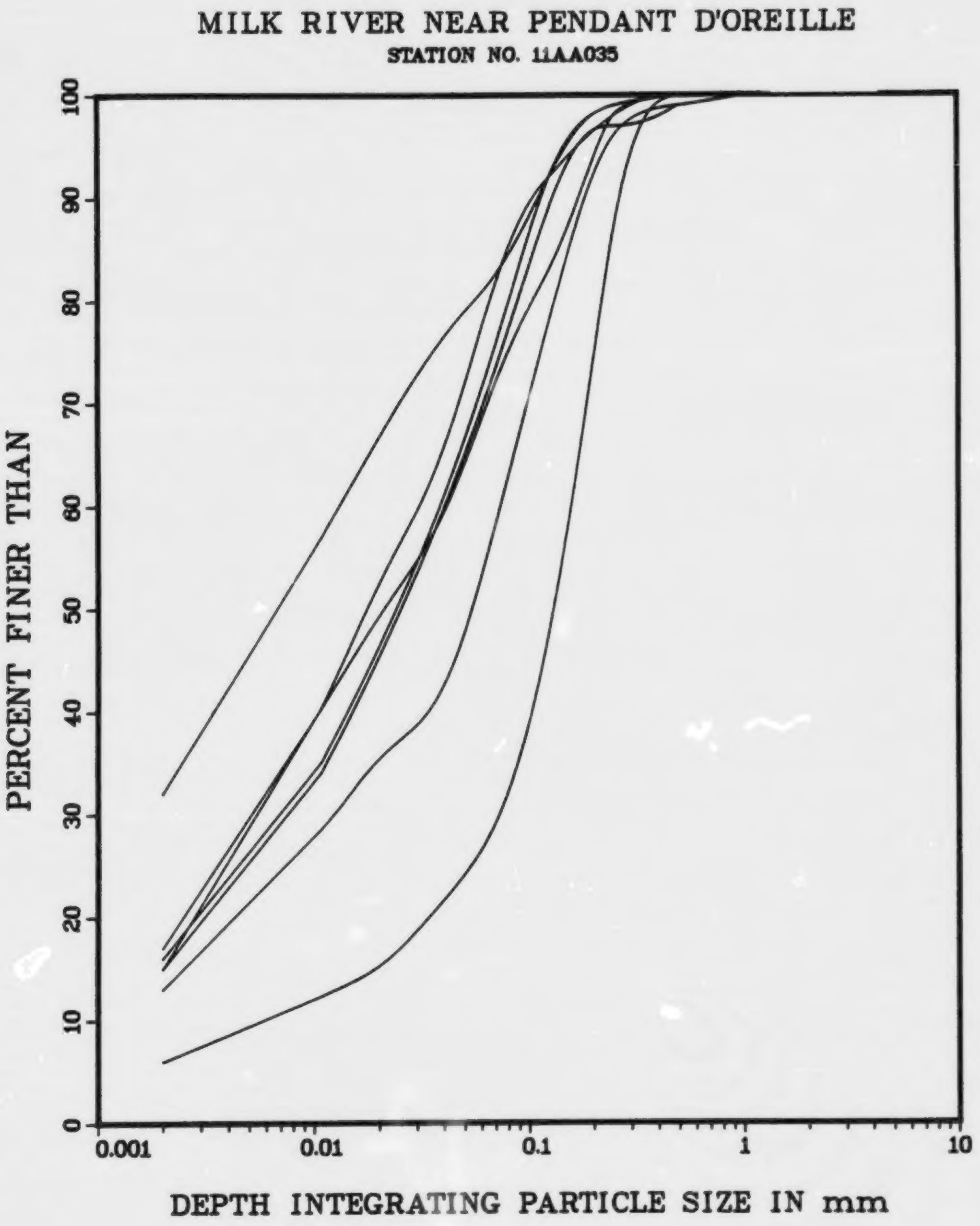


Figure F-7

Composite Plot of Particle Size Analysis Data

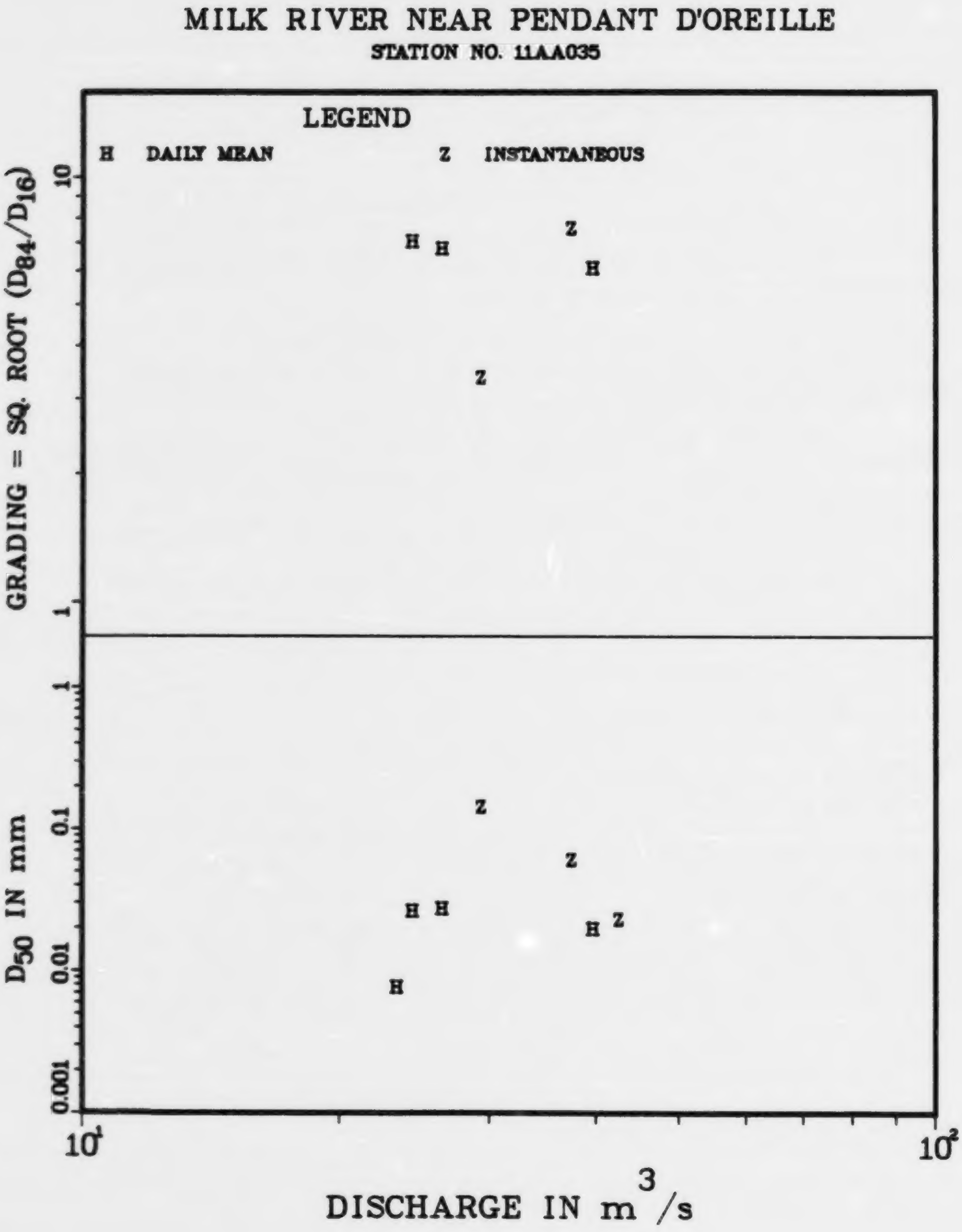


Figure F-8

Particle Size Statistics Compared to Streamflow Discharge

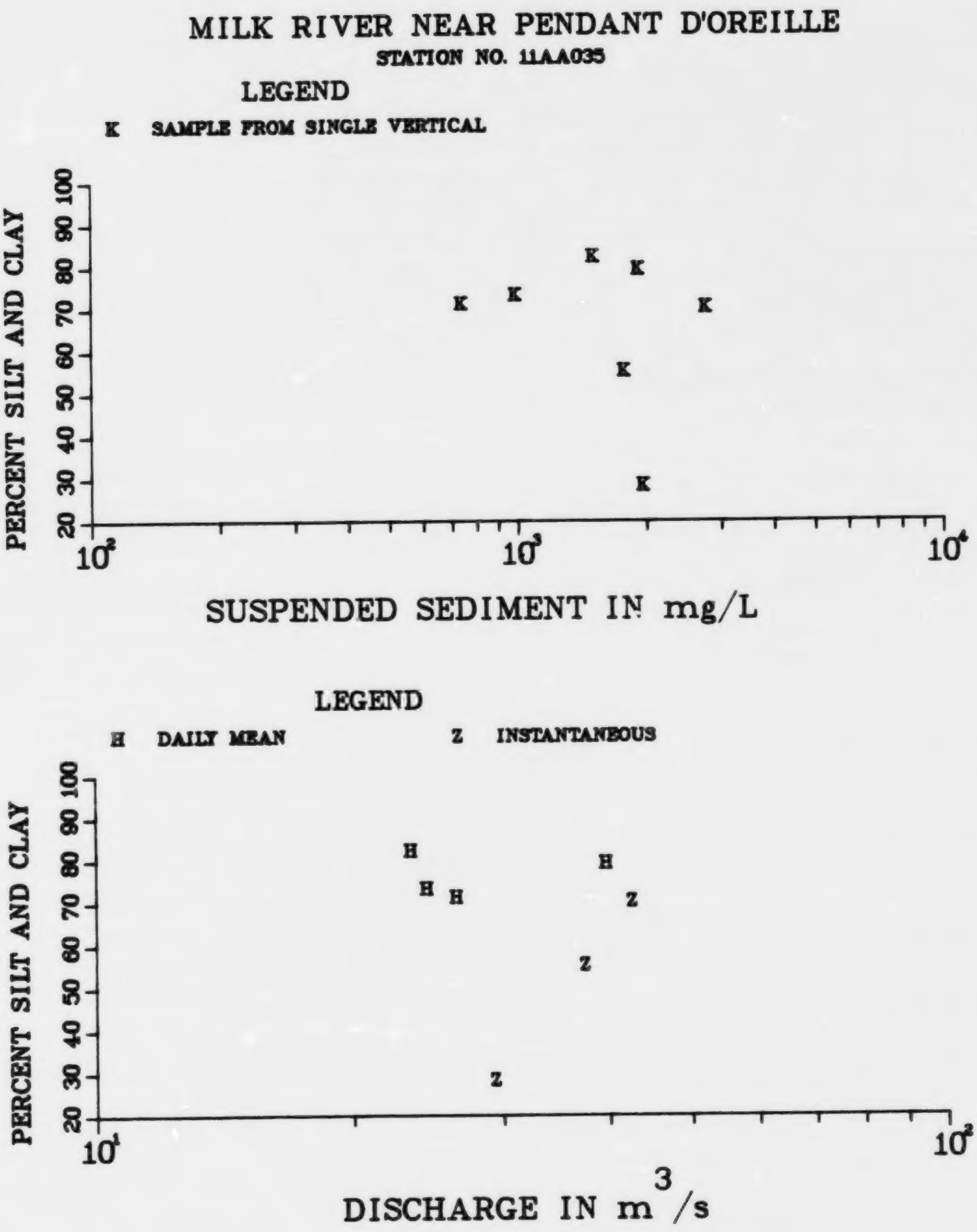


Figure F-9

Percentage of Silt and Clay (Less than 0.062 mm)
in the Suspended Sediment Load
as a Function of Concentration and Discharge.

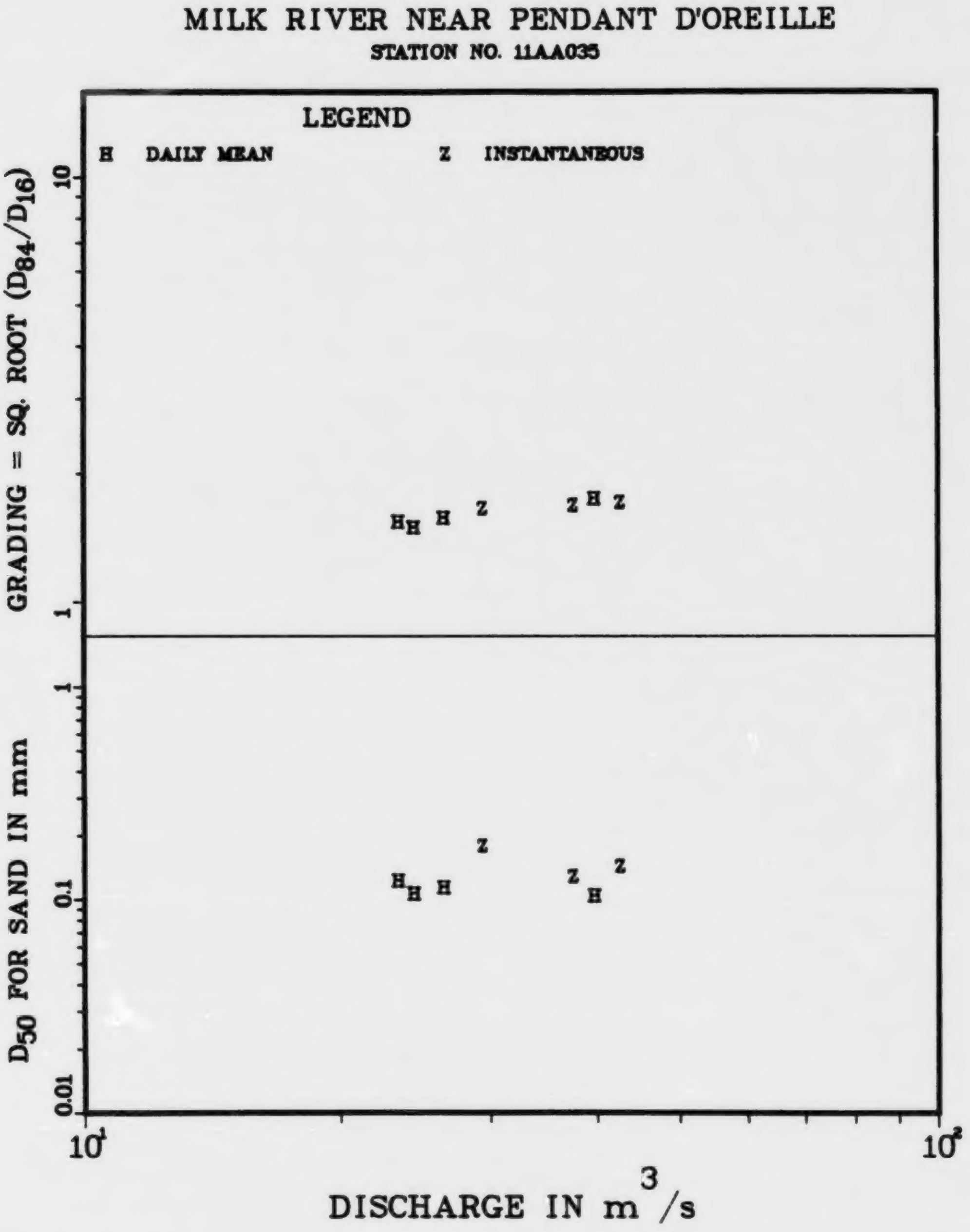


Figure F-10

Particle Size Statistics for Sand Component
Compared to Streamflow Discharge

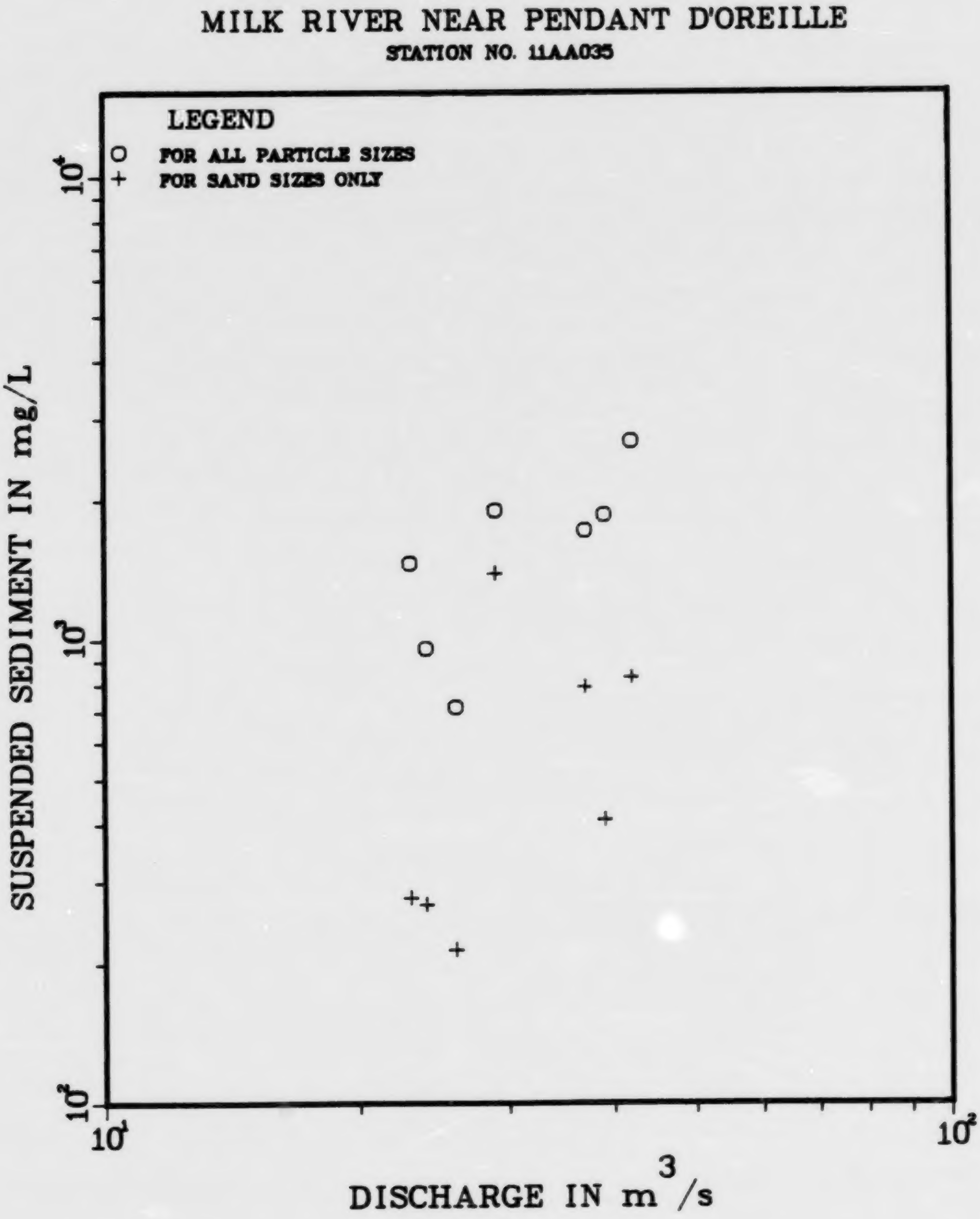


Figure F-11

Variation of Concentration with Discharge
Showing the Sand Cmponent of the Suspended Sediments

5.0 BED MATERIAL DATA

No bed material samples were taken.

6.0 BED LOAD DISCHARGE

No measurements of bed load were made.

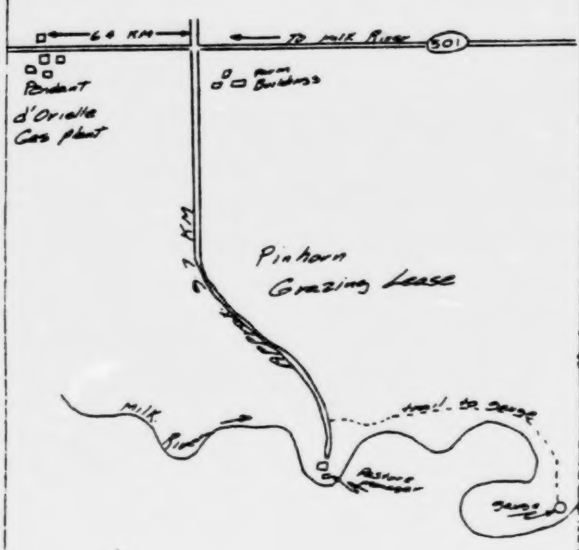
7.0 DISSOLVED SOLIDS DATA

Dissolved solids data are a by-product of the laboratory analysis of suspended sediments for either concentration or for particle sizes. These data are contained in tabulated form and can be found on pages F-25 and F-26.

STATION DESCRIPTION

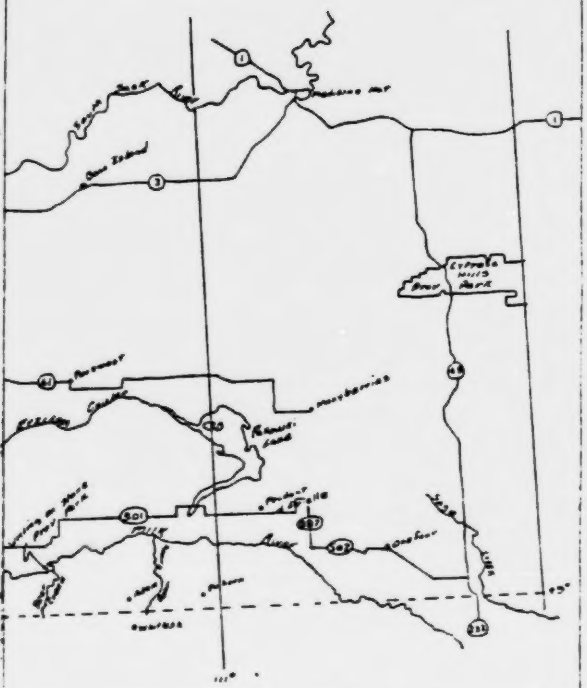
DETAILED SKETCH OF STATION LOCATION

Scale= *Not to scale*


N
6.4 KM
To Milk River
501
Farm Buildings
Pendant d'Orielle Gas plant
9.7 KM
Pinhorn Grazing Lease
Milk River
trail to gauge
Pasture
Gauge

SKETCH OF STATION LOCATION

Scale=


N
1
South Sask River
Medicine Hat
Seven Persons
3
1
Cypress Hills Prov Park
41
Foremost
61
Manyberries
Etzikom Coulee
Pakowki Lake
Writing on Stone Prov Park
501
Pendant d'Oreille
887
Milk River
502
Onefour
232
49°
111°

STATION DESCRIPTION

Station No. 11AA035 Basin

Station Name Milk River near Pedant d' Oreille

Located in .N.W. 1/4 Sec. 15 Tp. 2 Rge. 7 W 4

Latitude 49° 07' 25" Longitude 110° 52' 15"

Established May, 1978 by H.M. Wagner

Name of Observer

Address

Rate of Pay Freq. of Obs.

Location of station with respect to towns, etc:

Approx. 6.4 Km. east, 9.7 Km. south and 3 Km. east of pendant d' Oreille gas plant.

Description of gauge and equipment:

Brytex shelter

A-71 recorder

manometer

Measurement description:

Measurements are made by wading or from cableway above gauge.

Prepared by: J.A. Date: June 12,1979

BENCH MARKS

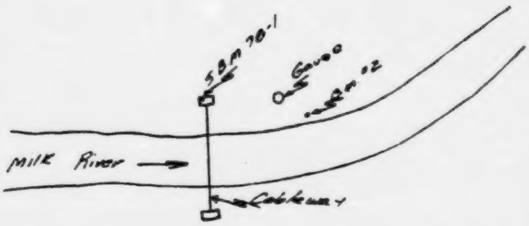
Give elevation of bench marks, type, and number or markings, and gauge datum.

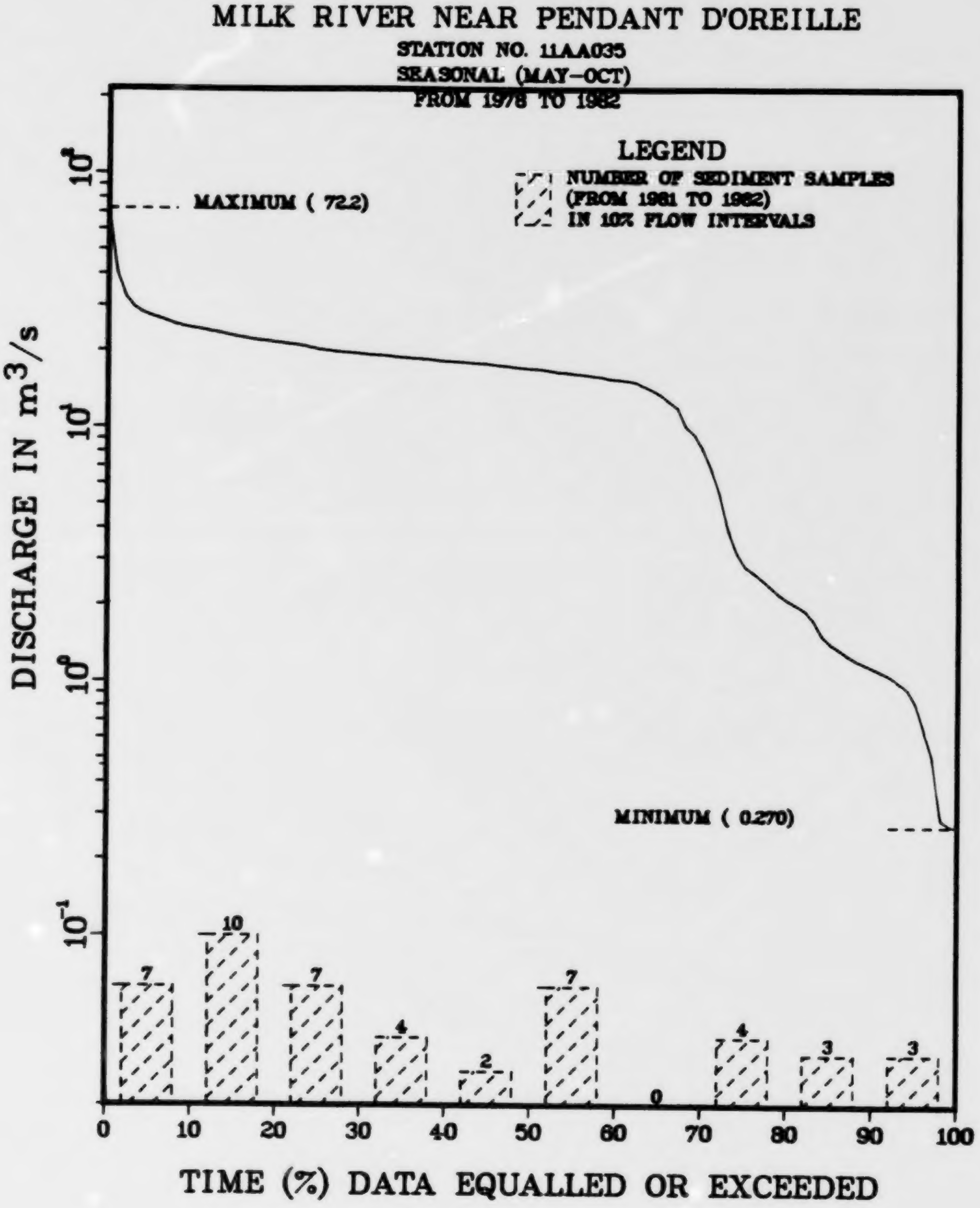
Gauge Datum= 26.518

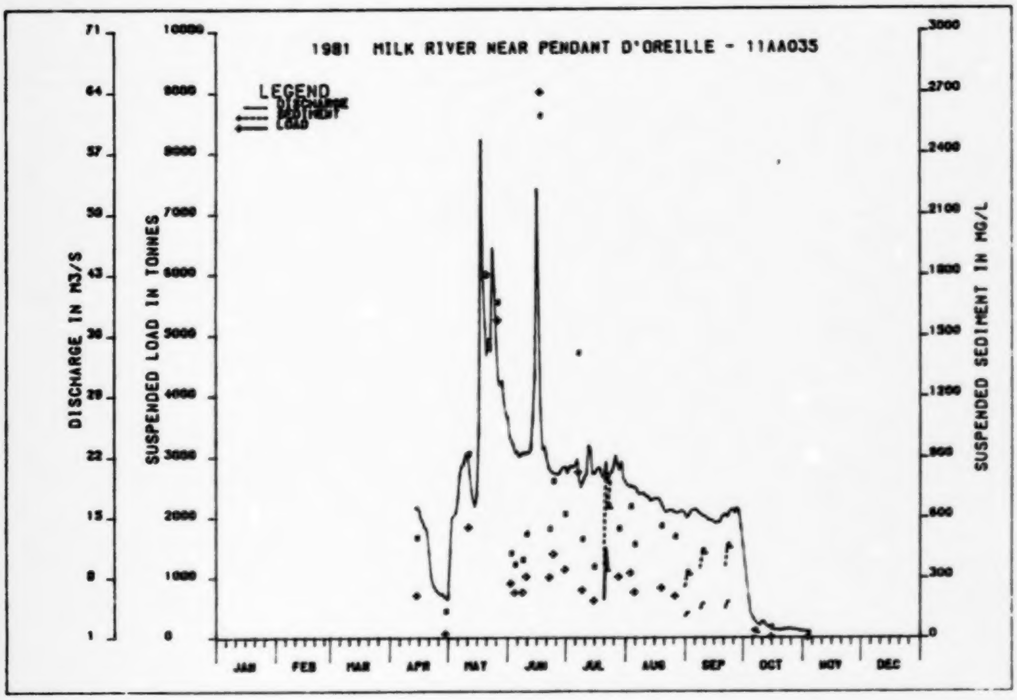
S.B.M. 78-1	Located in left bank deadman Elevation: 30.480 (assumed)
B.M.#2	Head of screw anchor painted orange beside bank in front of shelter. Elevation: 28.721 (ref. to S.B.M.78-1) (unstable)

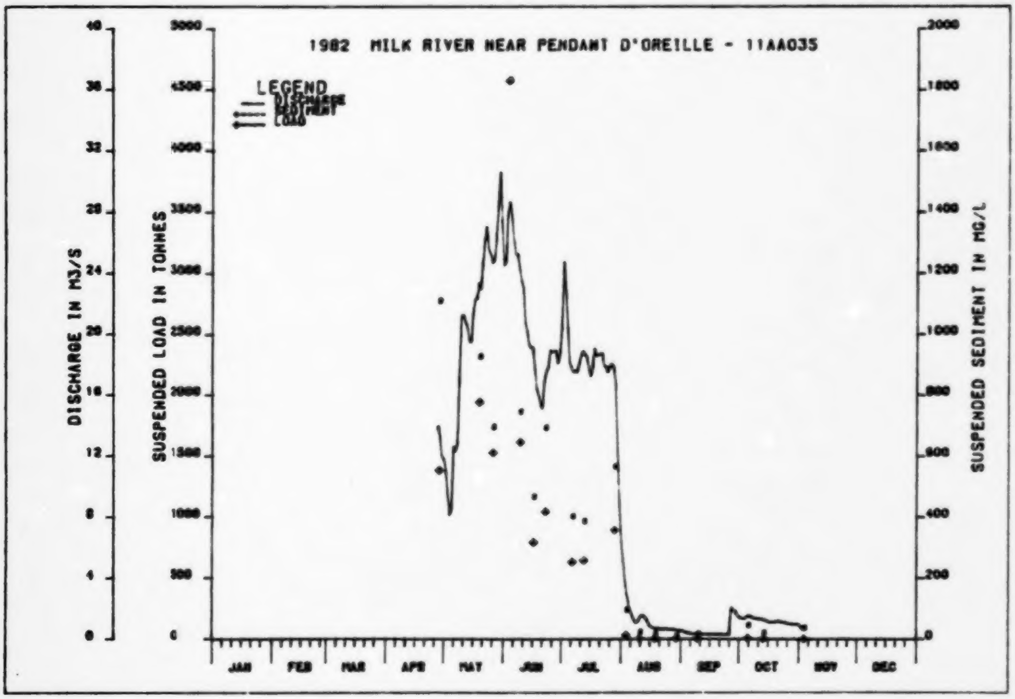
Metric

SKETCH OF BENCH MARKS


SBM 78-1
Gauge
BM #2
Milk River
Cableway


MILK RIVER NEAR PENDANT D'OREILLE
STATION NO. 11AA035
SEASONAL (MAY-OCT)
FROM 1978 TO 1982
LEGEND
NUMBER OF SEDIMENT SAMPLES
(FROM 1981 TO 1982)
IN 10% FLOW INTERVALS
MAXIMUM (72.2)
MINIMUM (0.270)
DISCHARGE IN m³/s
10^2
10^1
10^0
10^{-1}
7
10
7
4
2
7
0
4
3
3
0
10
20
30
40
50
60
70
80
90
100
TIME (%) DATA EQUALLED OR EXCEEDED


1981 MILK RIVER NEAR PENDANT D'OREILLE - 11AA035
LEGEND
DISCHARGE
SEDIMENT
LOAD
DISCHARGE IN M3/S
71
64
57
50
43
36
29
22
15
8
1
SUSPENDED LOAD IN TONNES
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
SUSPENDED SEDIMENT IN MG/L
3000
2700
2400
2100
1800
1500
1200
900
600
300
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC


1982 MILK RIVER NEAR PENDANT D'OREILLE - 11AA035
LEGEND
DISCHARGE
SEDIMENT
LOAD
DISCHARGE IN M3/S
40
36
32
28
24
20
16
12
8
4
0
SUSPENDED LOAD IN TONNES
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
SUSPENDED SEDIMENT IN MG/L
2000
1800
1600
1400
1200
1000
800
600
400
200
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC

MILK RIVER NEAR PENDANT D'OREILLE

MONTH	DAY	TIME	DISSOLVED SOLIDS (mg/L)	INSTANTANEOUS CONCENTRATION (mg/L)	DISCHARGE (m^3/s)
INSTANTANEOUS DATA FOR 1981					
APR	14	1215	176	509	16.7
APR	29	1005	295	127	6.00
MAY	11	1145	232	942	23.9
MAY	20	1315	309	1856	38.9
MAY	26	1300	287	1716	36.8
JUN	2	1130	209	429	25.7
JUN	4	1305	193	370	24.2
JUN	8	1110	180	395	23.3
JUN	10	1505	166	529	23.4
JUN	17	1135	265	2684	41.9
JUN	22	1135	197	557	23.2
JUN	24	1705	179	801	21.0
JUN	30	2130	163	633	21.7
JUL	7	1145	149	1458	24.1
JUL	9	1415	-	502	19.2
JUL	15	1430	157	360	20.6
JUL	21	1335	136	386	20.3
JUL	22	1335	140	809	23.0
JUL	23	1605	134	674	20.1
JUL	28	1415	122	658	21.8
AUG	3	1330	130	672	19.4
AUG	5	1515	124	476	19.7
AUG	19	1010	118	571	17.8
AUG	26	1505	119	515	16.3
SEP	1	1100	118	268	16.1
SEP	2	1155	116	328	15.4
SEP	9	1410	119	364	15.8
SEP	10	1210	118	439	15.7
SEP	22	1315	111	375	16.0
SEP	23	1240	112	468	15.5
OCT	6	1230	199	38	3.49
OCT	7	1210	217	24	3.08
OCT	15	1005	339	41	2.21
NOV	3	1300	428	10	1.72
INSTANTANEOUS DATA FOR 1982					
APR	28	1510	232	1152	15.0
MAY	19	1940	183	958	24.7

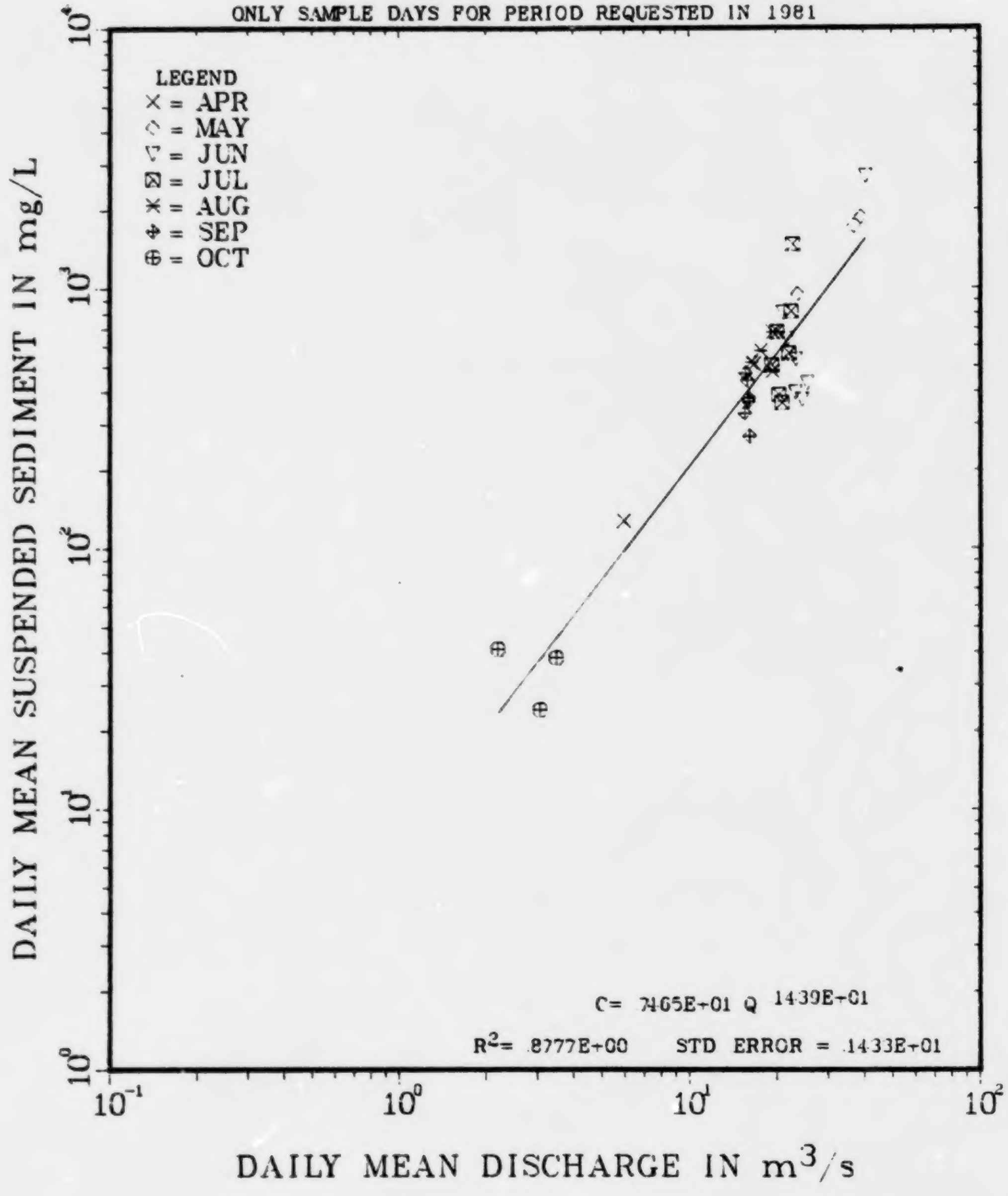
MILK RIVER NEAR PENDANT D'OREILLE

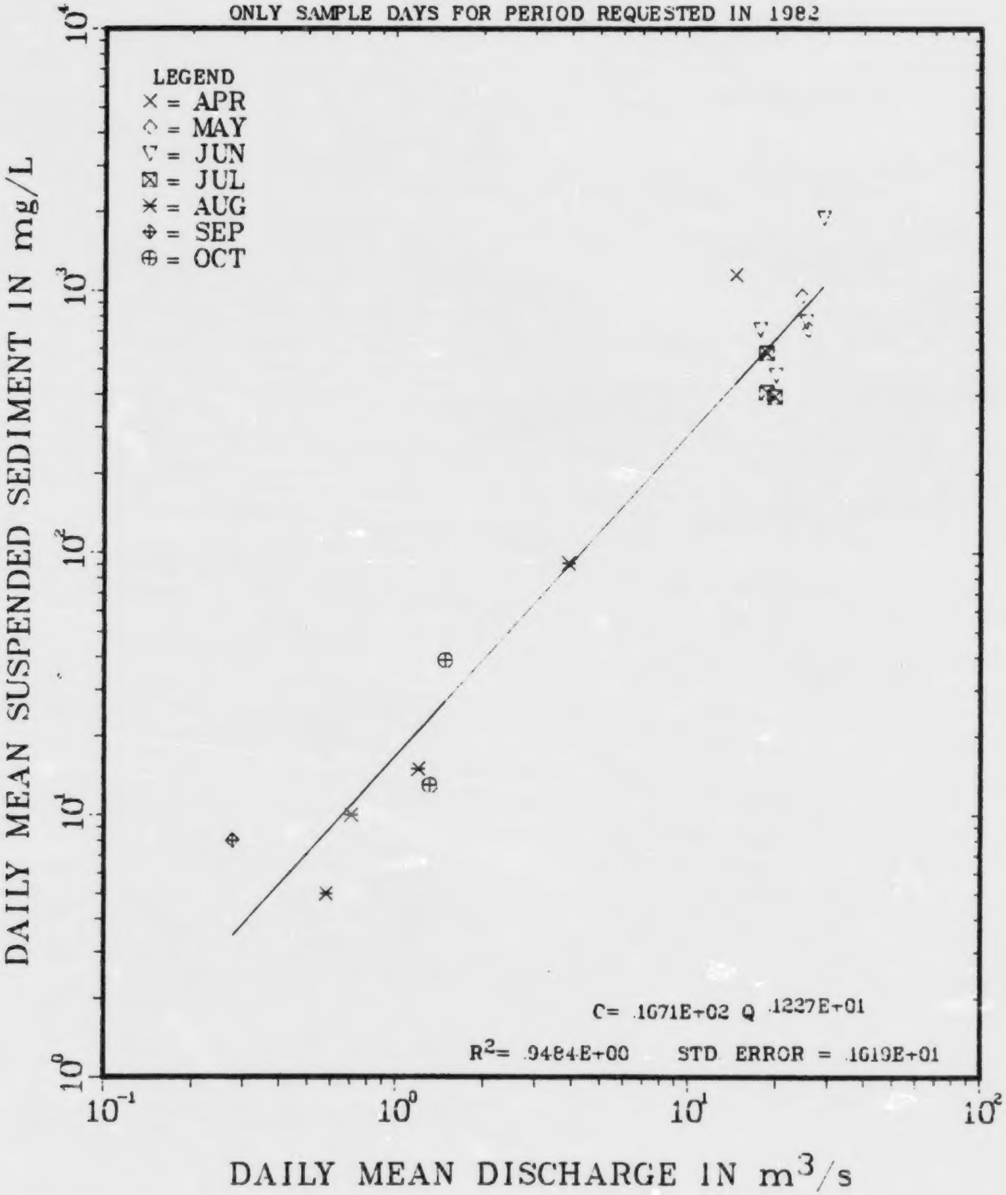
MONTH	DAY	TIME	DISSOLVED SOLIDS (mg/L)	INSTANTANEOUS CONCENTRATION (mg/L)	DISCHARGE (m^3/s)
		INSTANTANEOUS DATA FOR 1982 (cont'd)			
MAY	26	0950	175	715	25.3
JUN	3	1445	238	1901	29.1
JUN	9	1430	268	767	25.3
JUN	16	1325	242	477	19.5
JUN	22	1435	202	713	17.8
JUL	6	1350	183	410	18.6
JUL	12	1415	135	394	19.7
JUL	28	1050	124	581	18.3
AUG	3	0920	188	91	3.14
AUG	10	1625	345	15	1.13
AUG	18	1330	462	10	0.707
AUG	29	1420	517	5	0.572
SEP	9	1138	587	8	0.277
OCT	5	1500	507	39	1.48
OCT	13	1235	514	13	1.30
NOV	3	1335	536	30	0.614

MILK RIVER NEAR PENDANT D'OREILLE

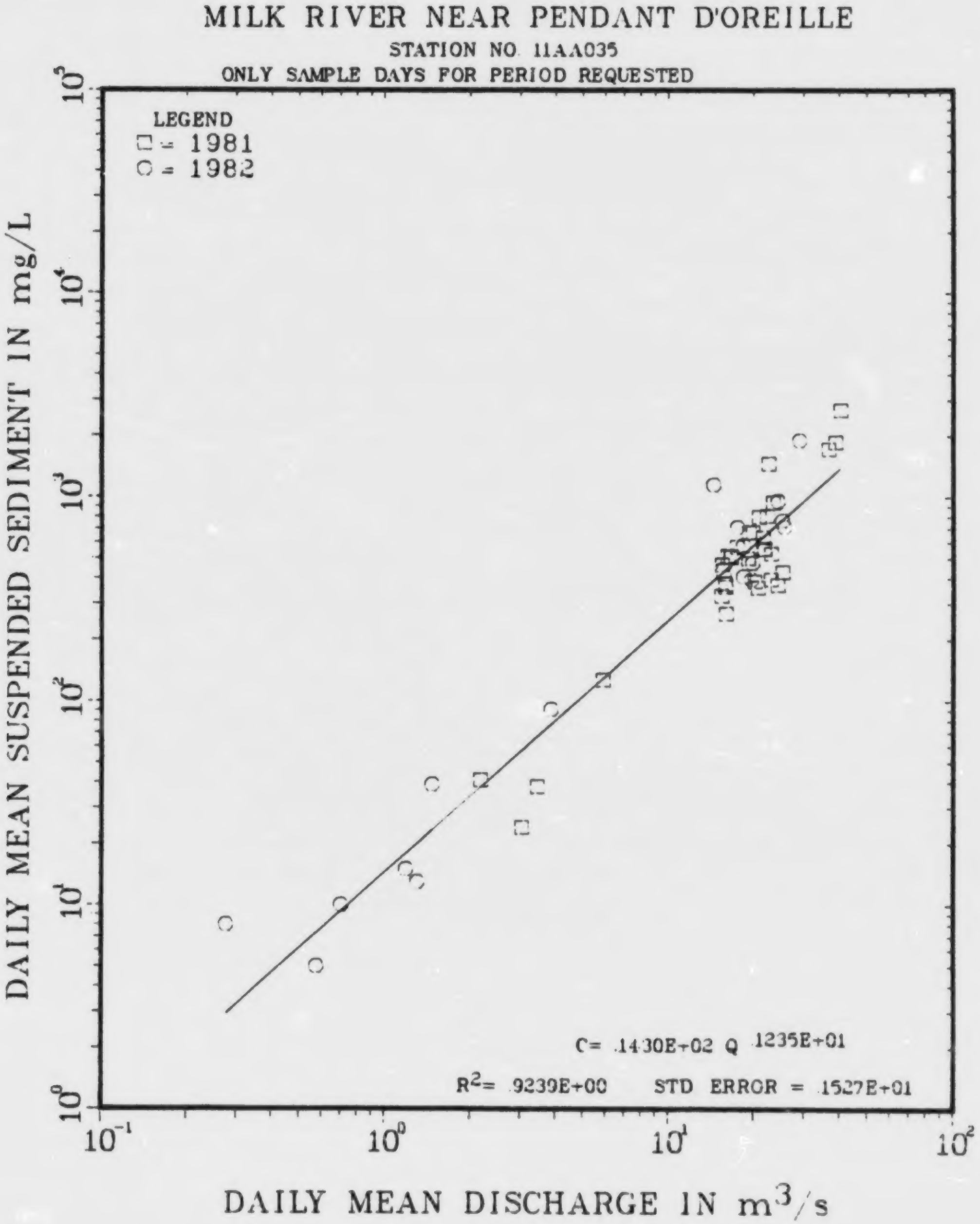
STATION NO. 11AA035

ONLY SAMPLE DAYS FOR PERIOD REQUESTED IN 1981





MILK RIVER NEAR PENDANT D'OREILLE
STATION NO. 11AA035
ONLY SAMPLE DAYS FOR PERIOD REQUESTED IN 1982



MILK RIVER NEAR PENDANT D'OREILLE

STATION NO. 11AA035

ONLY SAMPLE DAYS FOR PERIOD REQUESTED

APPENDIX G

MILK RIVER AT EASTERN CROSSING

11AA031

TABLE OF CONTENTS

MILK RIVER AT EASTERN CROSSING

Page

1.0 HYDROMETRIC STATION DESCRIPTION G-4

1.1 Period of Record G-4
1.2 Gauging Station Description G-4
1.3 Channel and Valley Features G-4
Table G-1: River Valley, Flat and Channel Features G-5
1.4 Stereo Pair G-6
Figure G-1: Stereo Pair Aerial Photograph G-6
1.5 On Site Photographs G-7

2.0 HYDRAULIC DATA G-9

2.1 Rating Curve G-9
Figure G-2: Stage-Discharge Relation G-9
2.2 Cross-Section G-10
Figure G-3: Cross-Section under Cableway G-10
2.3 Specific Gauge Diagram G-11
Figure G-4: Specific Gauge Diagram: 1917 to 1986 ...... G-11
2.4 Discharge versus Area; Mean Velocity; Mean Depth G-12
Figure G-5: Discharge versus Area G-12
Figure G-6: Discharge versus Mean Velocity G-12
Figure G-7: Discharge versus Mean Depth G-13
Table G-2: Hydraulic Data at Cableway G-13

3.0 SUSPENDED SEDIMENT DATA G-17

3.1 Period of Sampling and Frequency G-17
Table G-3: Number of Suspended Sediment Samples G-17
3.2 Sampling Location, Procedures and Equipment G-18
3.3 Representativity G-18
Figure G-8: Recurrence Intervals of Total Seasonal Discharge (dam^3) G-19
3.4 Suspended Sediment Discharge Data G-18
Figure G-9: Suspended Sediment Concentration versus Discharge G-20
Table G-4: Seasonal Suspended Sediment Load G-21
Table G-5: Suspended Sediment Load Simulated by Regression Techniques G-21

4.0 SUSPENDED SEDIMENT PARTICLE SIZE DATA G-23

Table G-6: Particle Size Analysis of Depth Integrated Suspended Sediment Samples G-23
Figure G-10: Composite Plot for Suspended Sediment Particle Size Distributions G-24

TABLE OF CONTENTS

MILK RIVER AT EASTERN CROSSING

Page

Figure G-11: Particle Size Statistics Compared to Streamflow Discharge G-25
Figure G-12: Percentage of Silt and Clay in the Suspended Sediment Load as a Function of Total Concentration and Discharge G-26
Figure G-13: Particle Size Statistics for the Sand Component as Compared to Streamflow Discharge G-27
Figure G-14: Variation of Concentration with Discharge Showing the Sand Component of the Suspended Sediment G-28

5.0 BED MATERIAL DATA G-29

Table G-7: Particle Size Analysis of Bed Material G-29
Figure G-15: Bed Material Particle Size Distribution G-30

6.0 BED LOAD DISCHARGE DATA G-29

Table G-8: Bed Load Discharge G-29

7.0 DISSOLVED SOLIDS DATA G-31

DIAGRAMS AND TABLES OF DATA G-32

- Station Description G-32
- Flow Duration Curve G-33
- Streamflow and Sediment Hydrographs G-34
- Instantaneous Suspended Sediment Data G-37
- Published Sediment Data G-46
- Annual Suspended Sediment Rating Curves G-52

MILK RIVER AT EASTERN CROSSING: 11AA031

1.0 HYDROMETRIC STATION DESCRIPTION

1.1 PERIOD OF RECORD

A manual gauging station, near the present location, was established in 1909 in the SE3-1-5-W.4 and was known as "Milk River at Spencer's Lower Ranch". This site was approximately 300 metres upstream of the International Boundary Crossing. The station was moved and upgraded to an automatic water level recording gauging station in November 1917. This station was known as "Milk River at Eastern Crossing" and was located in NE6-37N-9 EPM (Montana). The station remained at this location until October 30, 1969, when it was moved 16 kilometres downstream into the NE7-37N-10 EPM (Montana). This is its present location.

1.2 GAUGING STATION DESCRIPTION

The present gauging station is situated on the right bank, just below a curve and high cliff banks and above a long, relatively straight, reach (Figure G-1).

The gauging station consists of a 1.5-metre diameter wood stave well, linked to the stream by two metal pipe intakes. The well is covered by a standard walk-in shelter which houses an A-71 Stevens strip chart water level recorder. In addition, the shelter houses a telemark, which provides 'on demand' water level information.

Streamflow measurements during moderate and high flows (greater than 15 m^3/s) are made from a cableway which is located 10 metres upstream of the gauging station. Low flow streamflow discharge measurements are made by wading; during the past several years, directly under the cableway.

A copy of the fieldman's station description can be found on page G-32.

1.3 CHANNEL AND VALLEY FEATURES

The gauging station is located in a "badlands" type of terrain. The significant features of the valley and river are listed in Table G-1. The interpretation is based upon aerial photographic analysis (Figure G-1) at a scale of 1:30 000. The classification and interpretation is based on an abbreviated form of that developed by Kellerhals et al. (1976).

TABLE G-1

MILK RIVER AT EASTERN CROSSING

RIVER VALLEY, VALLEY FLAT AND CHANNEL FEATURES

GENERAL DESCRIPTION IN VINCITY OF HYDROMETRIC STATION (ABOVE VALLEY)

Terrain : Plains with Localized Badlands
Vegetation : Prairie Grasses
Land Use : North - No Cultivation
: South - Partly Cultivated

VALLEY CHARACTERISTICS ABOVE VALLEY FLAT

Slumping of Valley Walls : Occasional to Frequent
Vegetation on Valley Walls : Almost None

TERRACES

Presence : Fragmentary
Number of Levels : Several

RELATION OF CHANNEL TO VALLEY

Valley Type : Stream Cut Valley
Relation of Channel to Valley Bottom: Not Obviously Degrading or Aggrading
Relation of Channel to Valley Walls or to Resistant Terraces : Frequently Confined

DESCRIPTION OF VALLEY FLAT

Presence : Fragmentary
Extent : Wide (>5 water surface widths)
Vegetation : Grass and Shrubs

CHANNEL DESCRIPTION

Pattern : Irregular Meanders
Islands : Frequent (Sand Bars)
Bar Type : Point, Side and Mid-Channel Bars
Type of Flow : Uniform Water Surface

LATERAL CHANNEL ACTIVITY

Lateral Activity : Progression and Cut-offs
Lateral Stability : Slightly Unstable

CHANNEL BANK AND BEDS

Alluvial Bank Material : Clay and Silt (Cohesive)
Predominant Bed Material : Sand

1.4 STEREO PAIR

Figure G-1 is a stereo pair of the gauging station site. The photographs were taken in July of 1979 and the scale is 1:30 000.

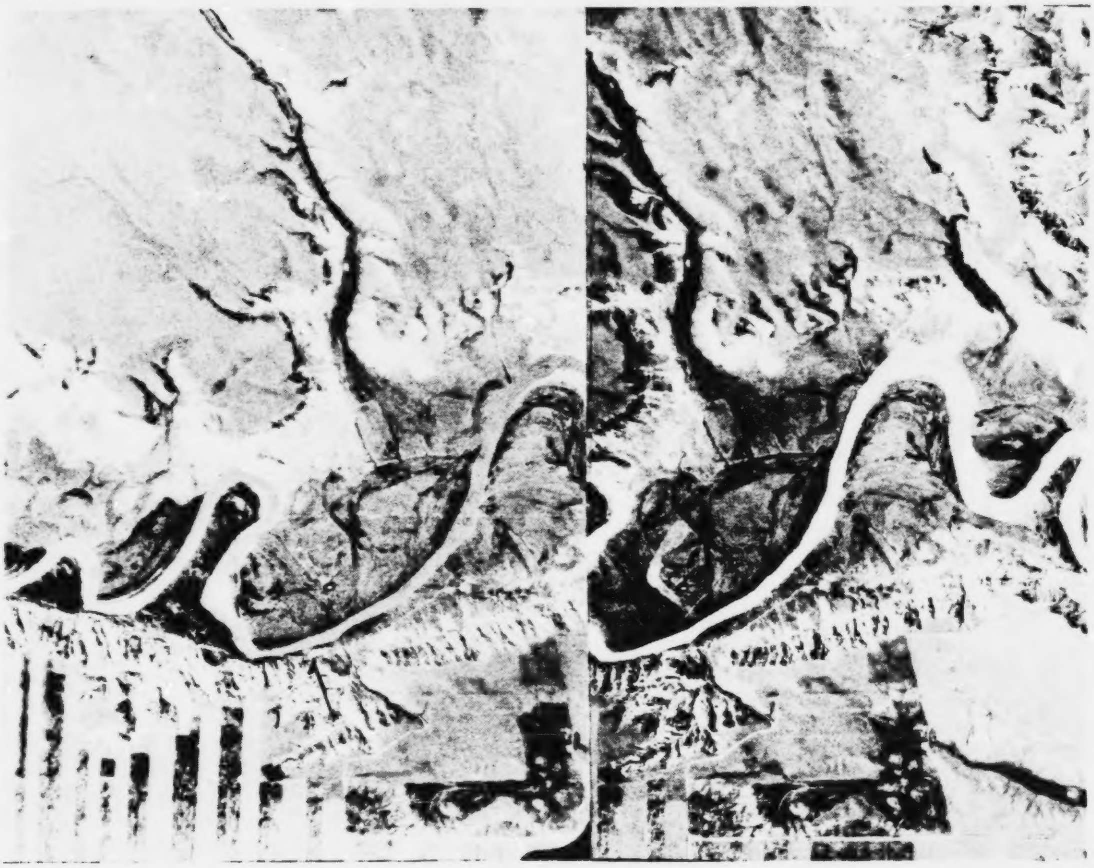


Figure G-1

Stereo Pair Aerial Photographs
Arrow Indicates Gauging Station Location
Milk River at Eastern Crossing

1.5 ON SITE PHOTOGRAPHS

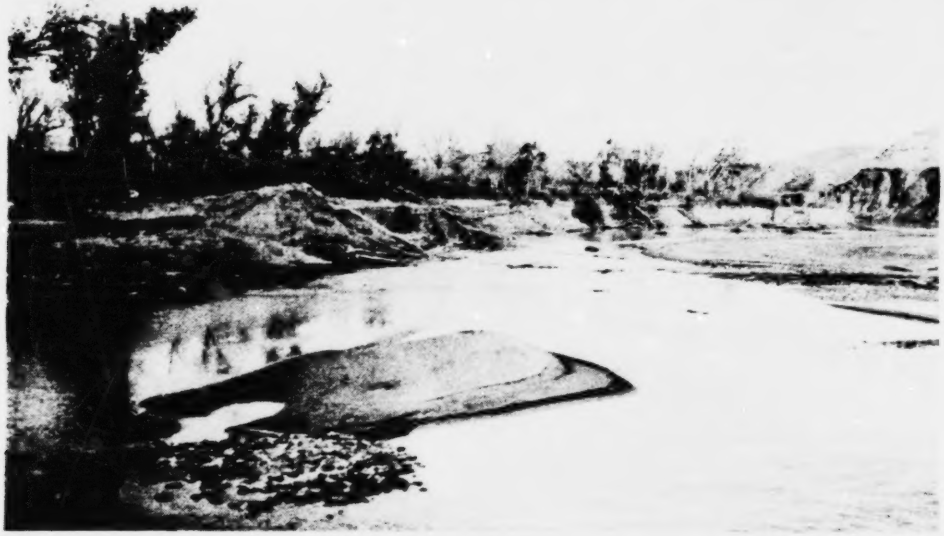


Photo G-1: Looking downstream from old gauge site. October 12, 1957.

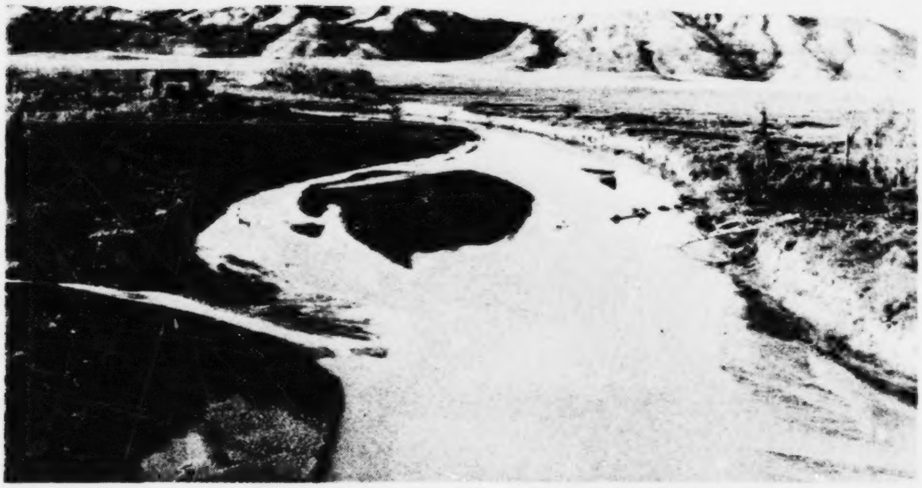
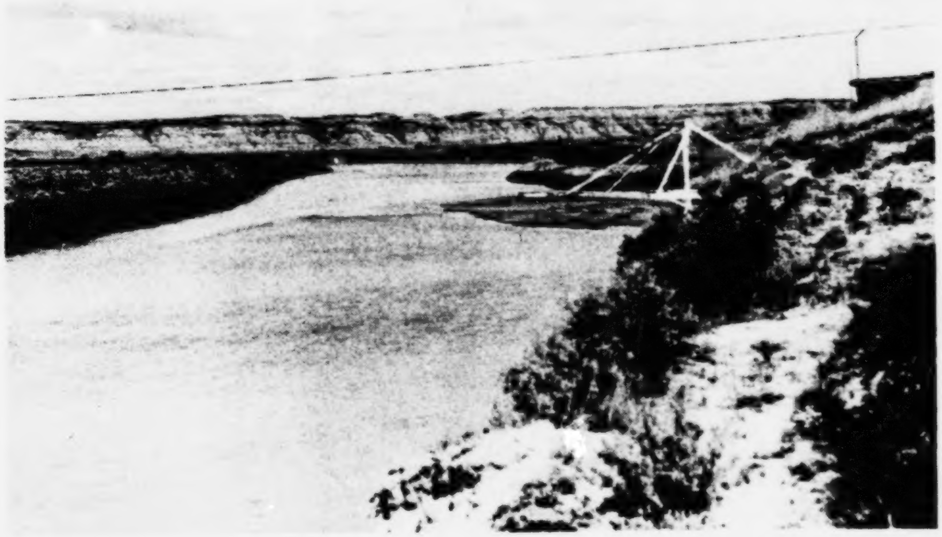


Photo G-2: Looking upstream from high bank directly above gauge at old site. October 12, 1957.



Above present gauge location, looking downstream.

Below present gauge location, looking upstream.

2.0 HYDRAULIC DATA

2.1 RATING CURVE

The stage-discharge relation for this station is depicted in Figure G-2. Because of the sand dune movement through this reach, the relation is highly unstable. Although only three separate curves have been used (Curve No. 1, 1971 to 1974; Curve No. 2, 1975 & 1976; Curve No. 3, 1977 to date), streamflow discharge measurements scatter widely about the relationship. This scatter is also depicted in Figure G-2.

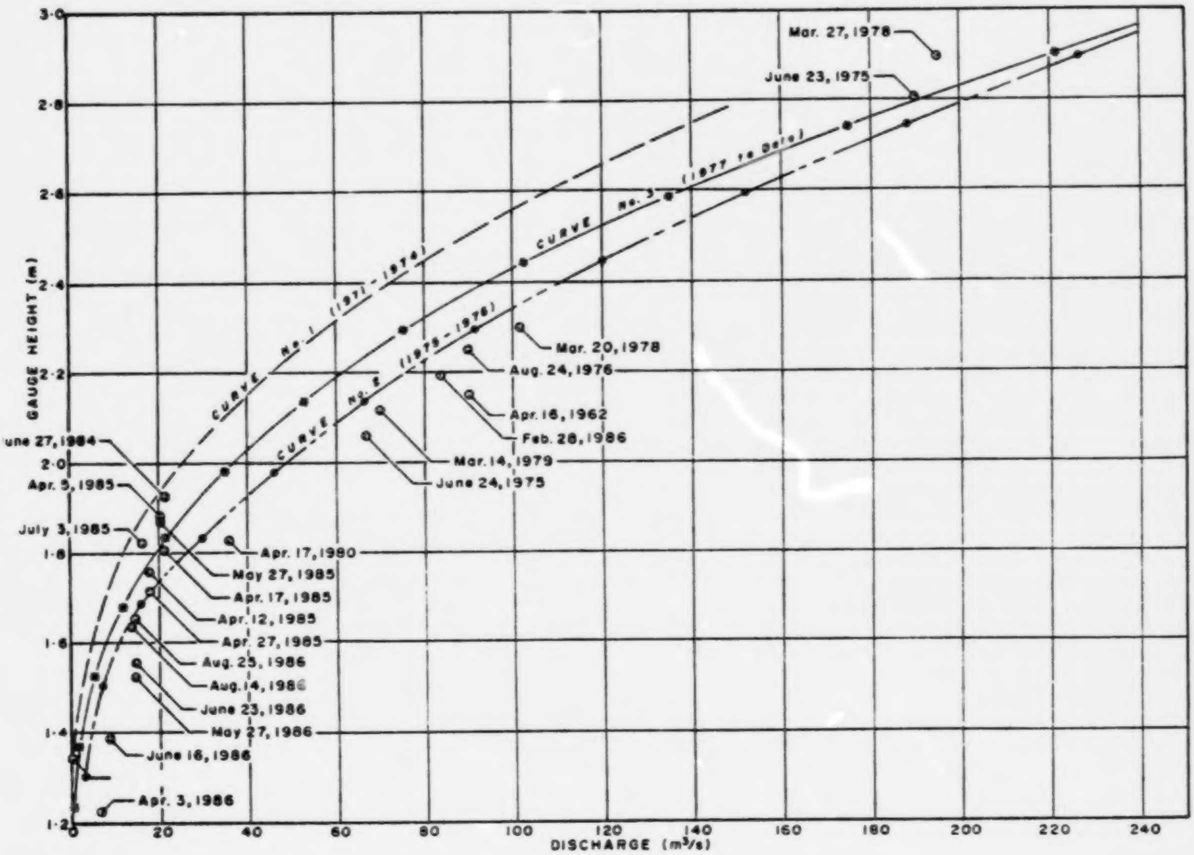


Figure G-2

Stage Discharge Relations, 1971 to 1986
Milk River at Eastern Crossing

2.2 CROSS-SECTIONS

The cross-section at the cableway crossing is depicted in Figure G-3. Three separate cross-sections have been superimposed, two from streamflow measurements made in 1986, and one from 1975. It is evident from this figure that the channel is highly variable because of migrating dunes, not only from year to year, but also within one year.

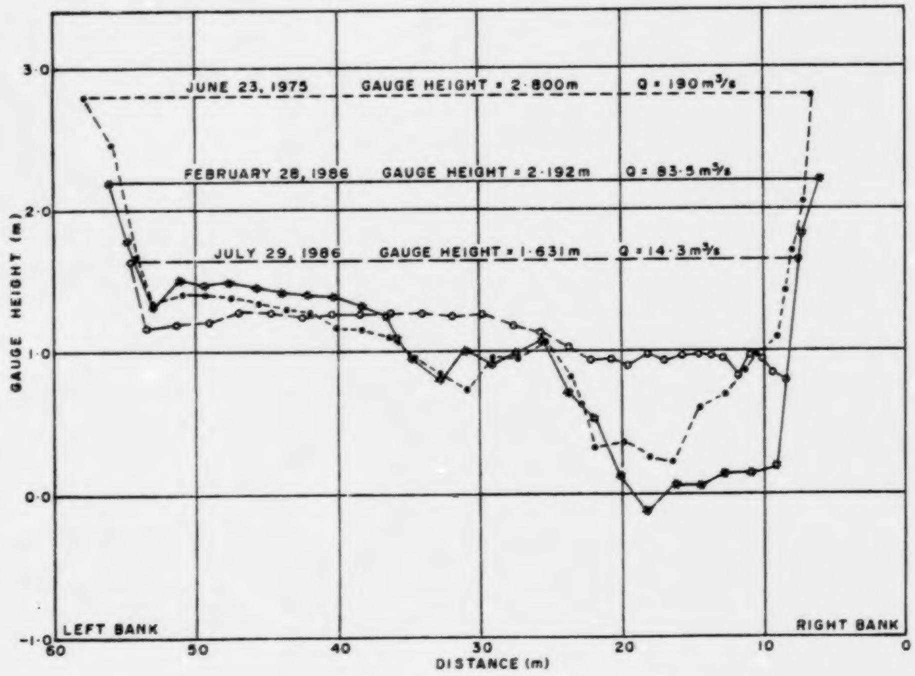


Figure G-3

Cross-Sections Under Cableway
Milk River near Eastern Crossing

2.3 SPECIFIC GAUGE DIAGRAM

Figure G-4 is a specific gauge diagram depicting the respective gauge heights at three different selected flow values (30, 14 and 3 m^3/s) throughout the period of record (excluding 1909 to 1916). This diagram is broken into two parts, 1917 to 1966 and 1971 to 1986, to correspond to the two separate gauge locations.

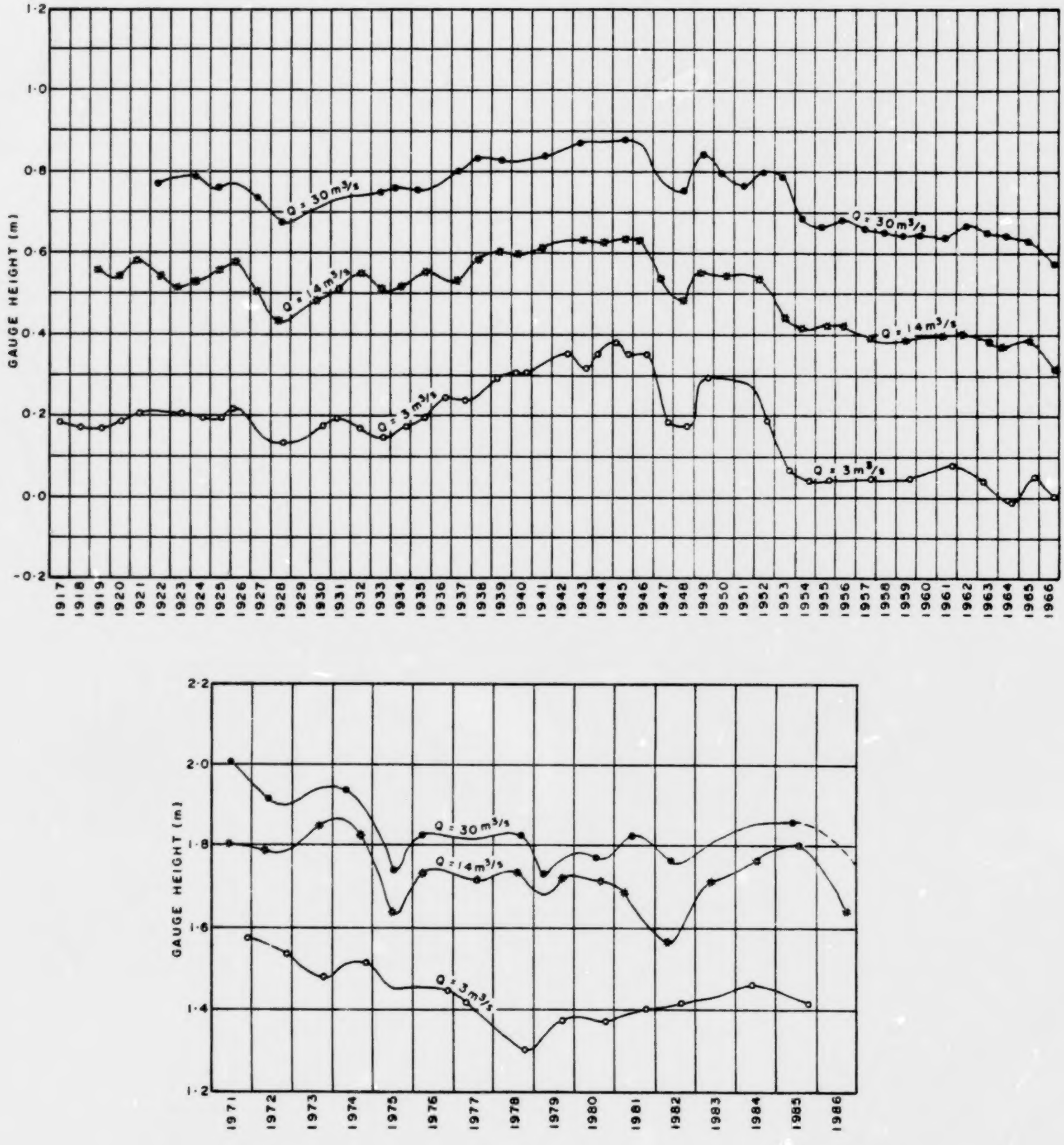


Figure G-4

Specific Gauge Diagram: 1917 to 1986
Milk River at Eastern Crossing

The specific gauge diagram indicates a cyclical aggradation/degradation cycle, although over the long term, there seems to be a general degradation taking place. At the old site, over the 50 year period, a degradation of about 0.2 metres has taken place, while at the new site, over a 15 year period, a degradation of about 0.15 metres is indicated.

2.4 DISCHARGE VERSUS AREA; MEAN VELOCITY; MEAN DEPTH; PLOTS

Separate plots of discharge versus cross-sectional area, mean velocity in the cross-section and mean depth in the cross-section (under the cableway) are shown in Figures G-5 to G-7. These figures were developed from streamflow discharge meaurements taken from the cableway, or by wading immediately below it, for the years 1975 to 1986, inclusive.

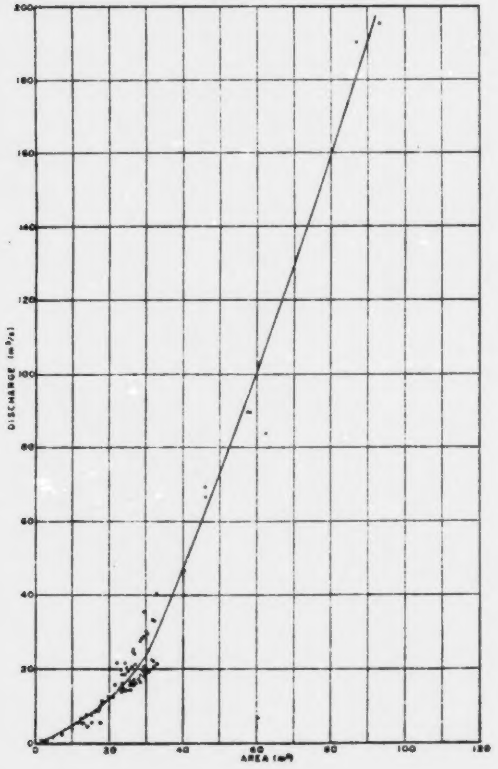


Figure G-5

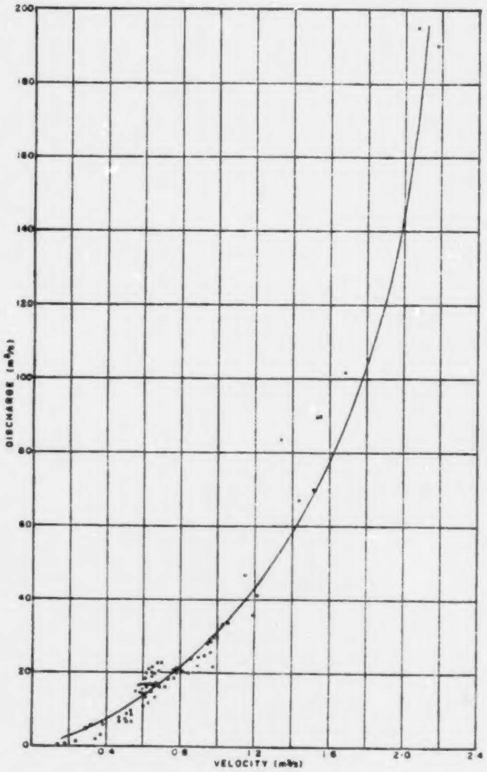


Figure G-6

Discharge versus Cross-Sectional Area   Discharge versus Mean Velocity
Milk River at Eastern Crossing

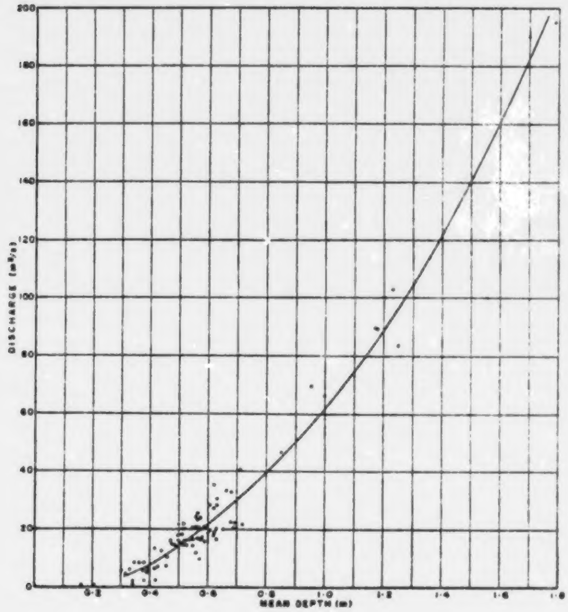


Figure G-7

Discharge Versus Mean Depth

The data from which figures G-5 to G-7, inclusive were derived are contained in Table G-2.

TABLE G-2

MILK RIVER AT EASTERN CROSSING

HYDRAULIC DATA AT CABLEWAY

Date	Discharge	Gauge Height (m)	Mean Velocity (m/s)	Area (m^2)	Width (m)	Mean Depth (m)
1986						
Sept.29	4.22	1.375	0.29	14.4	44.5	0.32
Sept.22	2.71	1.274	0.34	7.95	20.7	0.38
Sept.16	2.86	1.271	0.37	7.62	18.3	0.42
Sept.10	7.14	1.451	0.47	15.3	35.7	0.43
Aug. 25	14.5	1.655	0.58	24.9	46.9	0.53

TABLE G-2 (cont'd.)

Date	Discharge	Gauge Height (m)	Mean Velocity (m/s)	Area (m^2)	Width (m)	Mean Depth (m)
Aug. 14	14.0	1.640	0.59	23.6	47.5	0.50
July 29	14.3	1.631	0.59	24.1	47.5	0.51
July 10	15.9	1.649	0.59	26.8	45.1	0.59
June 23	14.9	1.557	0.64	23.1	46.9	0.49
June 16	8.52	1.384	0.52	16.5	46.9	0.35
May 27	14.5	1.521	0.60	24.1	47.5	0.51
May 14	14.5	1.441	0.65	22.3	46.9	0.48
Apr. 28	11.5	1.366	0.63	18.1	32.3	0.56
Apr. 15	10.6	1.366	0.60	17.7	38.1	0.46
Apr. 3	6.29	1.225	0.51	12.4	31.4	0.39
Mar. 28	5.61	1.201	0.47	12.0	30.5	0.39
Mar. 20	7.08	1.253	0.51	13.9	29.9	0.46
Mar. 12	9.09	1.295	0.53	17.3	30.5	0.57
Mar. 5	19.8	1.466	0.79	25.2	44.5	0.57
Feb. 28	83.5	2.192	1.34	62.6	50.0	1.25
1985						
Apr. 5	20.5	1.884	0.77	26.5	47.5	0.56
Apr. 12	18.0	1.753	0.74	24.3	47.2	0.51
Apr. 17	21.0	1.804	0.78	26.9	47.2	0.57
Apr. 29	18.0	1.716	0.77	23.2	46.6	0.50
May 14	19.8	1.771	0.85	23.2	45.1	0.51
May 27	20.4	1.865	0.69	29.7	47.5	0.63
June 5	24.5	1.795	0.93	26.4	47.5	0.56
June 17	19.2	1.850	0.66	29.2	47.5	0.61
July 3	16.5	1.820	0.59	27.1	46.6	0.58
July 30	14.7	1.817	0.62	23.5	45.1	0.52
Aug. 13	17.0	1.865	0.64	26.7	47.2	0.57
Aug. 27	16.9	1.847	0.62	27.1	38.1	0.71
Sept.16	21.6	1.789	0.98	22.1	44.5	0.50
1984						
Apr. 25	5.86	1.533	0.39	15.1	46.3	0.33
May 10	5.13	1.503	0.39	13.2	44.5	0.30
May 29	14.7	1.786	0.62	23.8	46.9	0.51
June 13	16.6	1.856	0.58	28.5	45.1	0.63
June 27	21.5	1.929	0.65	33.0	46.0	0.72
July 18	16.5	1.820	0.64	25.5	47.2	0.54
July 30	16.8	1.826	0.66	25.5	46.6	0.55
Aug. 15	15.5	1.850	0.60	25.7	43.6	0.59
Aug. 28	6.822	1.588	0.54	12.6	30.0	0.42
Sept. 5	1.67	1.314	0.34	4.93	14.3	0.34

TABLE G-2 (cont'd.)

Date	Discharge	Gauge Height (m)	Mean Velocity (m/s)	Area (m^2)	Width (m)	Mean Depth (m)
Sept.25	0.68	1.219	0.23	3.03	8.84	0.34
Oct. 16	0.29	1.152	0.18	1.58	7.59	0.21
Oct. 30	0.26	1.210	0.14	1.78	11.0	0.16
1983						
Mar. 15	5.83	1.524	0.32	18.0	46.9	0.38
Mar. 23	13.11	1.686	0.66	19.7	47.2	0.42
Apr. 7	16.0	1.725	0.69	23.3	46.9	0.50
Apr. 21	8.67	1.594	0.51	16.9	44.8	0.38
May 5	12.9	1.707	0.61	21.1	47.5	0.44
May 19	8.83	1.603	0.53	16.6	46.6	0.36
June 13	17.2	1.856	0.62	27.9	47.9	0.58
June 27	16.4	1.811	0.63	25.8	47.5	0.54
July 14	19.1	1.859	0.65	29.5	47.5	0.62
July 16	18.5	1.865	0.65	28.4	47.5	0.60
1982						
Apr. 16	89.8	2.149	1.55	57.8	49.4	1.17
Apr. 23	14.8	1.564	0.64	23.0	47.5	0.48
Apr. 29	14.5	1.579	0.56	25.9	46.9	0.55
May 12	21.4	1.637	0.89	24.2	46.9	0.52
May 21	23.4	1.719	0.86	27.2	47.5	0.57
June 4	30.0	1.756	1.00	3.02	47.9	0.63
June 17	10.0	1.701	0.81	24.7	47.2	0.52
July 14	19.3	1.841	0.62	31.0	47.5	0.65
July 27	18.0	1.829	0.61	29.5	47.5	0.62
1981						
Mar. 19	10.7	1.756	0.77	26.8	46.6	0.58
Apr. 1	28.1	1.823	0.97	29.0	47.2	0.61
Apr. 7	15.7	1.707	0.72	21.9	46.9	0.47
Apr. 17	15.9	1.725	0.62	25.6	46.9	0.55
May 12	25.3	1.780	0.96	26.5	47.5	0.56
May 19	46.4	1.963	1.15	40.4	47.5	0.85
May 27	33.7	1.814	1.06	31.8	47.5	0.67
June 4	24.2	1.804	0.90	26.9	46.9	0.57
June 18	33.1	1.826	1.03	32.2	47.5	0.68
June 29	20.8	1.771	0.79	26.2	47.5	0.55
July 13	22.3	1.908	0.70	31.9	46.9	0.68
July 16	20.4	1.838	0.63	32.2	46.0	0.69
Sept.16	15.9	1.807	0.66	24.2	46.9	0.52

TABLE G-2 (cont'd.)

Date	Discharge	Gauge Height (m)	Mean Velocity (m/s)	Area (m^2)	Width (m)	Mean Depth (m)
1980						
Mar. 17	35.4	1.826	1.195	29.6	47.5	0.62
June 4	29.4	1.759	0.98	30.1	46.9	0.64
1979						
Mar. 14	69.7	2.134	1.51	46.1	48.5	0.95
Mar. 22	27.5	1.700	0.75	28.9	46.9	0.62
Apr. 13	28.6	1.695	0.96	29.7	46.9	0.63
1978						
Mar. 27	195.	2.899	2.079	93.8	52.4	1.79
Mar. 29	103.	2.301	1.69	60.9	49.4	1.23
Aug. 24	89.8	2.243	1.54	58.4	49.4	1.18
1975						
June 23	190.	2.801	2.18	87.0	51.2	1.70
June 24	66.5	2.057	1.44	46.2	46.9	0.99
June 27	40.2	1.811	1.22	32.9	46.6	0.71

3.0 SUSPENDED SEDIMENT DATA

3.1 PERIOD OF SAMPLING AND FREQUENCY

Suspended sediment sampling was performed during 1974 to 1976, inclusive and in 1981 and 1982. In actuality, only in 1981 and 1982 was there a full sampling program conducted, with sufficient samples taken to adequately define the time-concentration graphs. The gauge at Milk River at Eastern Crossing is very remote and thus only in 1981 and 1982 was the USGS fortunate enough to hire an observer to take suspended sediment samples, which were supplemented by samples taken by the field technicians on each visit to the site.

During 1974 to 1976 suspended sediment samples were taken only by field technicians on each visit to the station. However, in 1975 the number and timing of samples was such that it was felt they were sufficient to adequately define the time-concentration plot for the period May to October and thus provided the opportunity to compute daily suspended discharge quantitites.

Table G-3, which follows, details the number of suspended sediment samples taken.

TABLE G-3

MILK RIVER AT EASTERN CROSSING

NUMBER OF SUSPENDED SEDIMENT SAMPLES

YEAR	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	TOTAL
1974	-	1	3	2	2	2	1	-	11
1975	-	2	3	4	2	2	3	-	16
1976	1	3	3	2	2	3	-	-	14
1981	10	16	17	13	16	16	14	5	107
1982	-	3	15	16	17	9	3	5	68

3.2 SAMPLING LOCATION, PROCEDURES AND EQUIPMENT

During high flow periods, suspended sediment samples were taken by depth-integrating techniques from the cableway near mid-stream, utilizing a DH-59 sampler. During moderate and low flows, depth-integrating samples were taken utilizing a DH-48 sampler at a cross-section 100 metres below the gauge, but the location of the sample within the cross-section varied, depending on the ability of the observer to wade to mid-stream prior to obtaining his sample.

In 1982 four suspended sediment discharge measurements (suspended sediment samples taken at 5 sites in the cross-section; each at 20% of the flow points) were taken, and in 1981 thirteen measurements were performed. These measurements were made to adjust the single vertical sample to reflect the average suspended sediment concentration within the cross-section. For the most part (except during low flows in September and October) the correction factor was greater than unity.

3.3 REPRESENTATIVITY

With only five years of suspended sediment data, only three of which are complete with respect to suspended sediment discharge, it is unlikely that sufficient records are available to accurately assess sediment discharges over a period of years. Nonetheless, samples have been taken over a large range of discharges; from minimum flows up to a discharge of 174 m^3/s, compared with the maximum recorded instantaneous discharge for the period 1909 to 1986 of 238 m^3/s. Thus, bearing in mind the gross inaccuracies of applying sediment rating curves, inferences can be made on suspended sediment discharges utilizing regression techniques. It is also fortunate that in 1975 the fourth highest volume of discharge was recorded.

Figure G-8 is a recurrence interval plot of total seasonal (March to October) streamflow discharge for the period of record, with the three years of computed sediment discharge being indicated by arrows.

3.4 SUSPENDED SEDIMENT DISCHARGE DATA

Sufficient samples were collected in three years to compute, by standard technique, the suspended sediment load for varying periods. These loads and the period are detailed in Table G-4. Loads for 1960 to 1985 have also been computed by sediment rating curve regression techniques (Ashmore, 1986) and are contained in Table G-5. The values in Table G-5 have not been corrected by the exp. $2.65s^2$ factor, which has been determined (Ashmore, 1980) as the adjustment factor because of the tendency of sediment rating curves to underestimate suspended discharge. Figure G-9 contains a plot of discharge versus concentration for all samples. The annual rating curves and combined rating curve with the respective regression equation and statistical parameters can be found on pages G-52 to G-56.

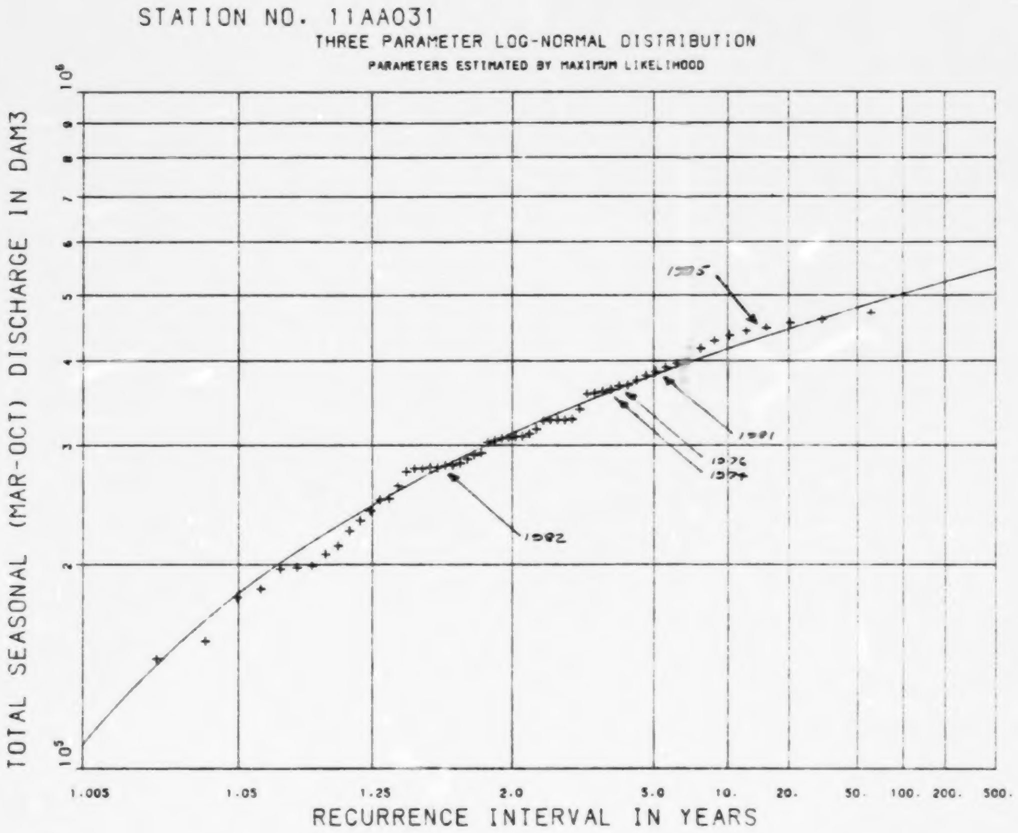
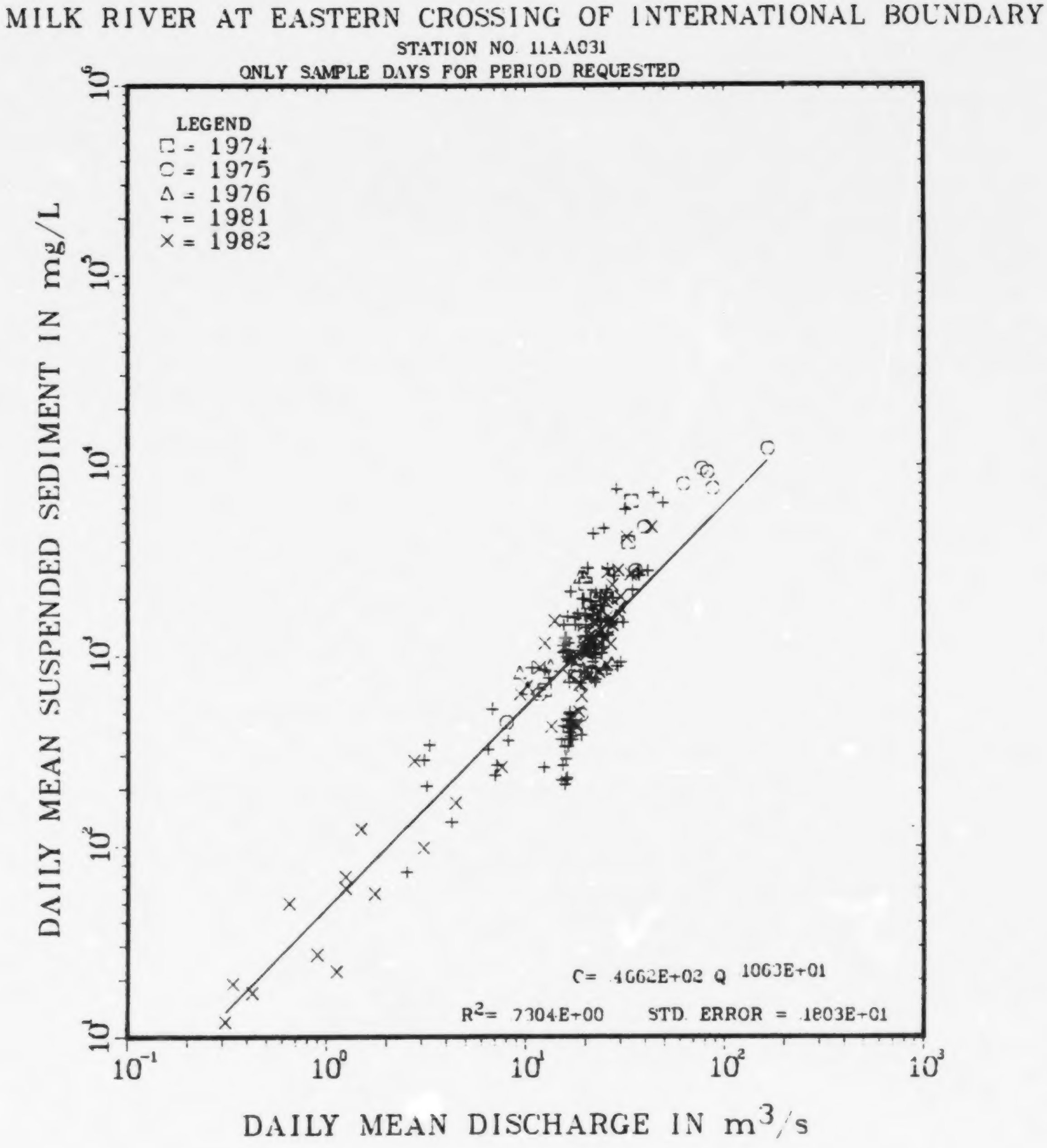


Figure G-8

Recurrence Intervals of Total Seasonal Discharge (dam^3)



MILK RIVER AT EASTERN CROSSING OF INTERNATIONAL BOUNDARY

STATION NO. 11AA031

ONLY SAMPLE DAYS FOR PERIOD REQUESTED

Figure G-9

Suspended Sediment Concentration versus Discharge

Table G-4 also gives a comparison of seasonal sediment discharge computed by the conventional method to that of the regression equation computed data adjusted by the exp. $2.65s^2$ correction factor.

TABLE G-4

MILK RIVER AT EASTERN CROSSING

SEASONAL SUSPENDED SEDIMENT LOAD

YEAR	SEASON	SUSPENDED SEDIMENT LOAD COMPUTED BY NORMAL PROCEDURES (TONNES)	SUSPENDED SEDIMENT LOAD SIMULATED BY REGRESSION TECHNIQUES (TONNES)
1975	Apr. to Sept.	1 730 000	1 481 000
1981	Mar. to Oct.	612 000	586 000
1982	Apr. to Oct.	305 000	568 000

TABLE G-5

SUSPENDED SEDIMENT LOAD SIMULATED BY REGRESSION TECHNIQUES

```
WATER SURVEY OF CANADA          MILK RIVER AT EASTERN CROSSING OF INTERNATIONAL BOUNDARY                    STATION NO. 11AA031
 11/03/87 . PAGE  1
SEDIMENT SURVEY SECTION
                                                     TOTAL LOADS IN TONNES
YEAR      JAN      FEB      MAR      APR      MAY      JUN      JUL      AUG      SEP      OCT      NOV      DEC      ANNUAL
1960                     178297    13070    87455    55970    43350    45660    30819      207                     454828
1961                       2204    27994    46817    58860    43670    41440    32793     1774                     255652
1962                      30510    59766    70600    58674    47440    38390     4159       59                     309598
1963                       1386    35241    47753    68080    61480    48030    36685      102                     298758
1964                        241    35270   230936   296530    23983    56940    60097     1566                     705563
1965                      15751   609485    29557   265620    76314    58000    51525     1853                    1108104
1966                      51093    28250    58292   156800    71760    59790    46103     1437                     473524
1967                     106626    67176   577555    87147    63420    55500    48620     2142                    1008186
1968                      30049    39499   107940   101740    71590    66860    62235     6444                     486357
1969                     266075   289383    37720   114410   116550    53880    28631      602                     907251
1970                       9907    25474    66863   109982    52270    51230    32388      404                     348517
1971                       5778    38288    54347    23452    64380    52850    56660    17175                     310930
1972                     413516    32421   114275    97514    76490    69660    63860    26725                     894462
1973                       5087     3546    32708    54930    47090    41904     1419       24                     186678
1974                      19207    67425   137622    62727    67030    54090    42263      740                     451104
1975                         73   133061   437000   907152    38231    72810    56753     3897                    1249977
1976                      43738    18262    81036    88930    77480    71200    41720     9840                     433207
1977                       1541     4822    30365    48180    12593     3994     1735      145                     103375
1978                     873774    50027    23980    34819    64129    89296    43313     1098                    1180436
1979                     518795    78167    73079    65406    47580    44690    13644      134                     841496
1980                      11716    66997    83190    92700    55060    49710    24022      358                     383754
1981                      35823    36936   152450   114410    68050    43330    38160     3035                     492194
1982                      19935   237722    89215    91860    57817     1290      167      205                     498210
1983                      12703    31509    17200    43360    56520    43510     5685       29                     210716
1984                      16589    13488    12280    41079    38060    36720      214       16                     160456
1985                       4332    47945    68120    67710    24029    41010    46696     2840                     302682

MEAN                     103000    80400   106000   108000    56400    49700    33500     3190                     541000
DEV.                     205000   127000   129000   103000    21000    18600    21100     6110                     335000
```

NOTE: To use the values in Table G-5, they should be increased by a factor of exp. $2.65s^2$.

In 1975 and 1981 the data computed by regression techniques compares favorably with the data computed by normal procedures, but in the very low sediment discharge year of 1982 the regression technique greatly over-estimates the sediment discharge.

Using the flow duration curve (page G-33) and the seasonal mean rating curve, the mean seasonal (March to October) load for the years 1960 to 1985, inclusive was computed as 642 000 tonnes, which compares very favorably with the 644 000 tonnes from Table G-5.

The actual instantaneous data utilized in the plots of concentration versus streamflow discharge can be found on pages G-37 to G-45. In addition, hydrographs of streamflow and sediment discharge for 1974 to 1976 and 1981 to 1982 are found on pages G-34 to G-36. Copies of published suspended sediment data can be found on pages G-46 to G-51.

4.0 SUSPENDED SEDIMENT PARTICLE SIZE DATA

Particle size information for 23 suspended sediment samples are contained in Table G-6 and are plotted in composite in Figure G-10.

TABLE G-6

PARTICLE SIZE ANALYSES OF DEPTH INTEGRATED SUSPENDED SEDIMENT SAMPLES

WATER SURVEY OF CANADA
09/09/85 , PAGE 1
SEDIMENT SURVEY SECTION

MILK RIVER AT EASTERN CROSSING OF INTERNATIONAL BOUNDARY
DEPTH INTEGRATING PARTICLE SIZE ANALYSIS OF SUSPENDED SEDIMENT

STATION NO. 11AA031

SAMPLE IDENTIFIER DATE	TIME	DISCHARGE (M3/S)	CONC. (MG/L)	PERCENT FINER THAN INDICATED SIZE, IN MICROMETRES 2	4	8	16	31	62	125	250	500	1000	2000	TOTAL D50	GDG	SAND D50	GDG	PERCENT CLAY	SILT	SAND
JUL 14 1976	1310	22.1 M	1 200 K	12	17	23	30	40	57	84	96	99	100		48.6	5.9	108.4	1.6	17	40	43
MAR 19 1981	1430	20.7	2 950 R	11	18	24	33	41	52	73	90	95	98		56.7	7.4	137.0	1.9	18	34	48
MAR 26 1981	1240	19.6 M	1 740 R	22	30	40	49	60	69	88	97	99	100		17.2	*	112.5	1.5	30	39	31
APR 7 1981	1330	15.7	1 070 R	14	20	27	38	45	58	83	96	99	100		42.8	7.0	113.0	1.5	20	38	42
APR 13 1981	0900	16.3 M	1 290 K	06	10	14	20	23	34	54	80	91	96		111.6	5.2	170.2	2.0	10	24	66
MAY 7 1981	0710	28.6	6 810 K	45	56	67	76	80	86	91	98	100			2.9	*	164.8	1.8	56	30	14
MAY 19 1981	1430	46.3	6 120 R	18	28	39	51	63	79	93	99	100			15.2	*	90.4	1.5	28	51	21
MAY 23 1981	1435	37.1 M	2 320 K	16	26	35	45	60	78	95	99	100			20.5	6.2	94.2	1.4	26	52	22
MAY 29 1981	1425	30.9 M	1 450 R	15	24	33	44	61	82	96	99	100			20.8	5.5	98.7	1.5	24	58	18
JUN 6 1981	0925	24.4 M	1 170 K	13	18	23	32	43	65	84	96	98	99		41.2	6.3	113.8	1.9	18	47	35
JUN 12 1981	1230	30.0 M	891 K	15	20	27	38	48	66	86	96	98	99		33.9	7.0	111.2	1.6	20	46	34
JUN 25 1981	1240	22.8 M	1 360 K	07	11	15	19	26	36	50	73	88	95		125.8	6.1	218.1	2.4	11	25	64
JUL 13 1981	1645	22.3	5 780 K	55	64	74	85	89	92	95	98	99	100		*	*	159.8	2.2	64	28	8
JUL 22 1981	2145	22.5 M	638 K	13	18	24	35	47	64	82	95	98	99		36.2	6.6	125.0	1.8	18	46	36
JUL 29 1981	1030	22.1	961 R	12	16	20	25	33	44	72	92	97	99		76.9	6.4	125.0	1.6	16	28	56
APR 29 1982	1115	14.5	1 600 R	19	30	43	54	61	69	82	96	97	99		12.1	*	141.1	1.8	30	39	31
MAY 10 1982	1021	27.2 M	2 110 K	05	11	36	62	71	79	90	99	100			10.9	4.1	121.8	1.6	11	68	21
MAY 20 1982	1036	25.8 M	1 830 K	08	17	23	32	43	55	69	86	93	97		47.3	7.8	177.7	2.3	17	38	45
MAY 30 1982	1454	43.0 M	4 320 K	06	16	54	62	75	86	93	97	99	99		7.4	3.4	125.0	2.1	16	70	14
JUN 4 1982	0725	30.1	2 010 R	10	16	24	33	48	66	87	96	99	100		33.3	5.3	109.1	1.6	16	50	34
JUN 11 1982	1903	23.8 M	1 150 K	10	13	21	31	45	67	90	99	100			38.9	4.3	100.2	1.5	13	54	33
JUL 3 1982	0806	29.4 M	1 690 K	12	18	26	37	50	66	82	94	99	100		31.0	6.5	131.3	1.8	18	48	34
OCT 1 1982	1306	1.93 M	1 280 K	51	87	96	96	97	98	100					*	*	99.1	1.2	87	11	2

DISCHARGE FOOTNOTE SYMBOLS
BLANK - INSTANTANEOUS
M - DAILY MEAN

CONCENTRATION FOOTNOTE SYMBOLS
R - SAMPLES COLLECTED IN SEVERAL VERTICALS
K - SAMPLE(S) COLLECTED IN A SINGLE VERTICAL

GDG (GRADING) = SQUARE ROOT (D84/D16)
* - UNABLE TO COMPUTE DUE TO INSUFFICIENT DATA

As indicated in Table G-6, the particle sizes of the suspended load are highly variable, with the clay fraction varying from 10 to 87 percent, the silt fraction from 11 to 70 percent, and the sand component from 8 to 66. All measured sediment was less than 2 mm in sieve diameter.

Figures G-11 to G-14 depict the particle size information in a variety of ways.

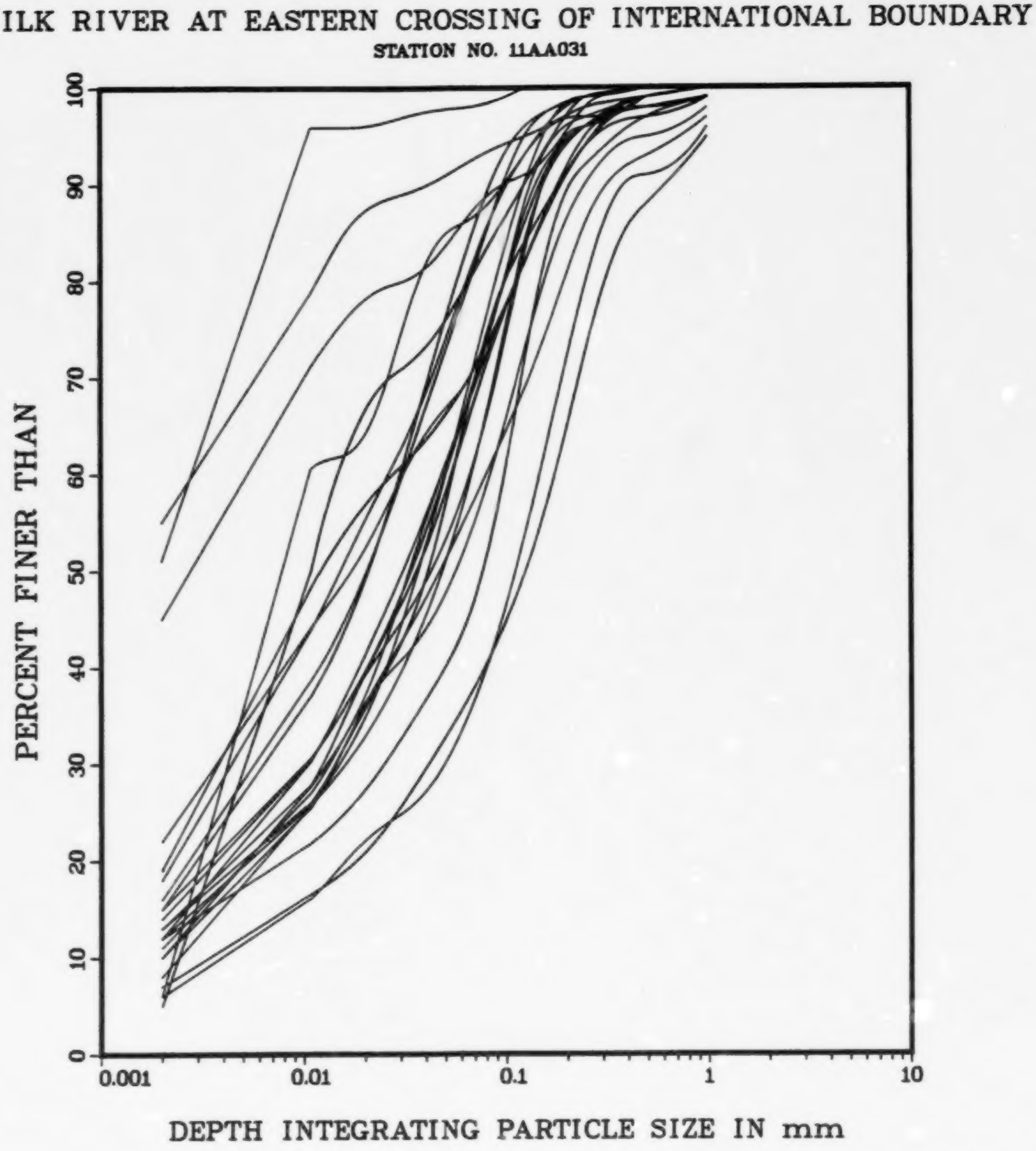


Figure G-10

Composite Plot for Suspended Sediment Particle Size Distribution

MILK RIVER AT EASTERN CROSSING OF INTERNATIONAL BOUNDARY

STATION NO. 11AA031

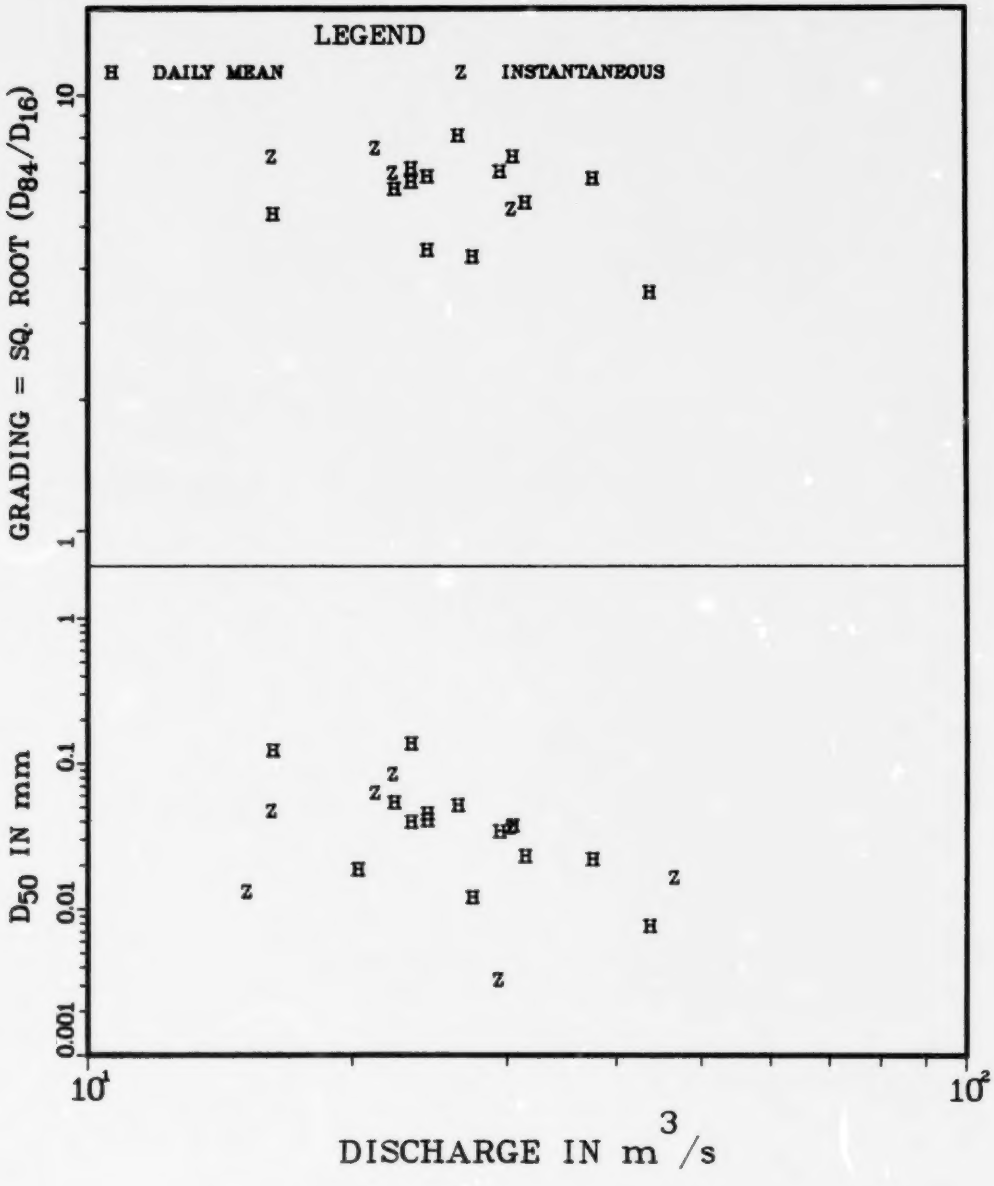


Figure G-11

Particle Size Statistics Compared to Streamflow Discharge

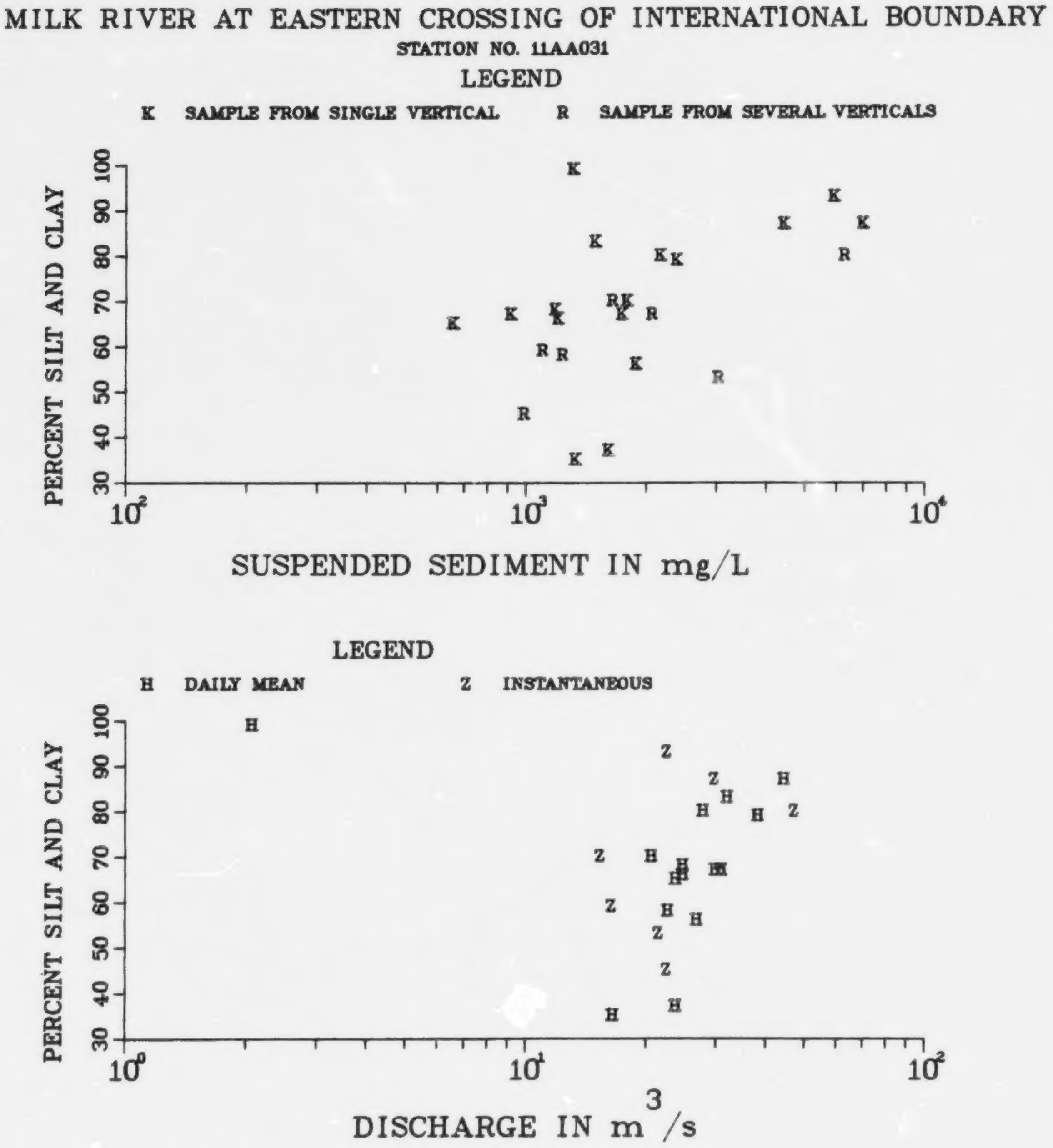


Figure G-12

Percentage Silt and Clay (defined as <0.062 mm)
in the Suspended Sediment Load as a Function
of Total Concentration and Discharge

MILK RIVER AT EASTERN CROSSING OF INTERNATIONAL BOUNDARY

STATION NO. 11AA031

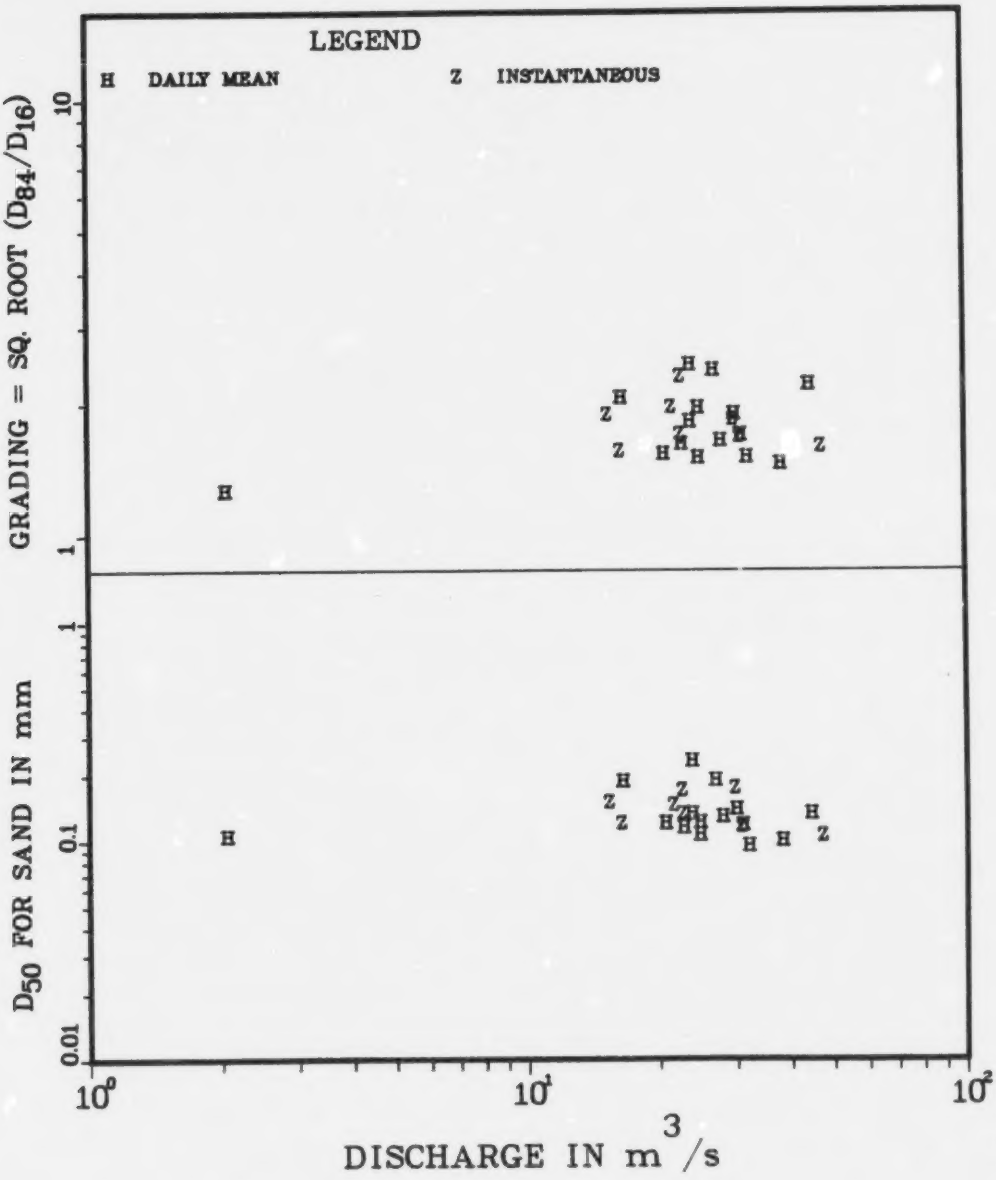


Figure G-13

Particle Size Statistics for the Sand Component as Compared to Streamflow Discharge

MILK RIVER AT EASTERN CROSSING OF INTERNATIONAL BOUNDARY

STATION NO. 11AA031

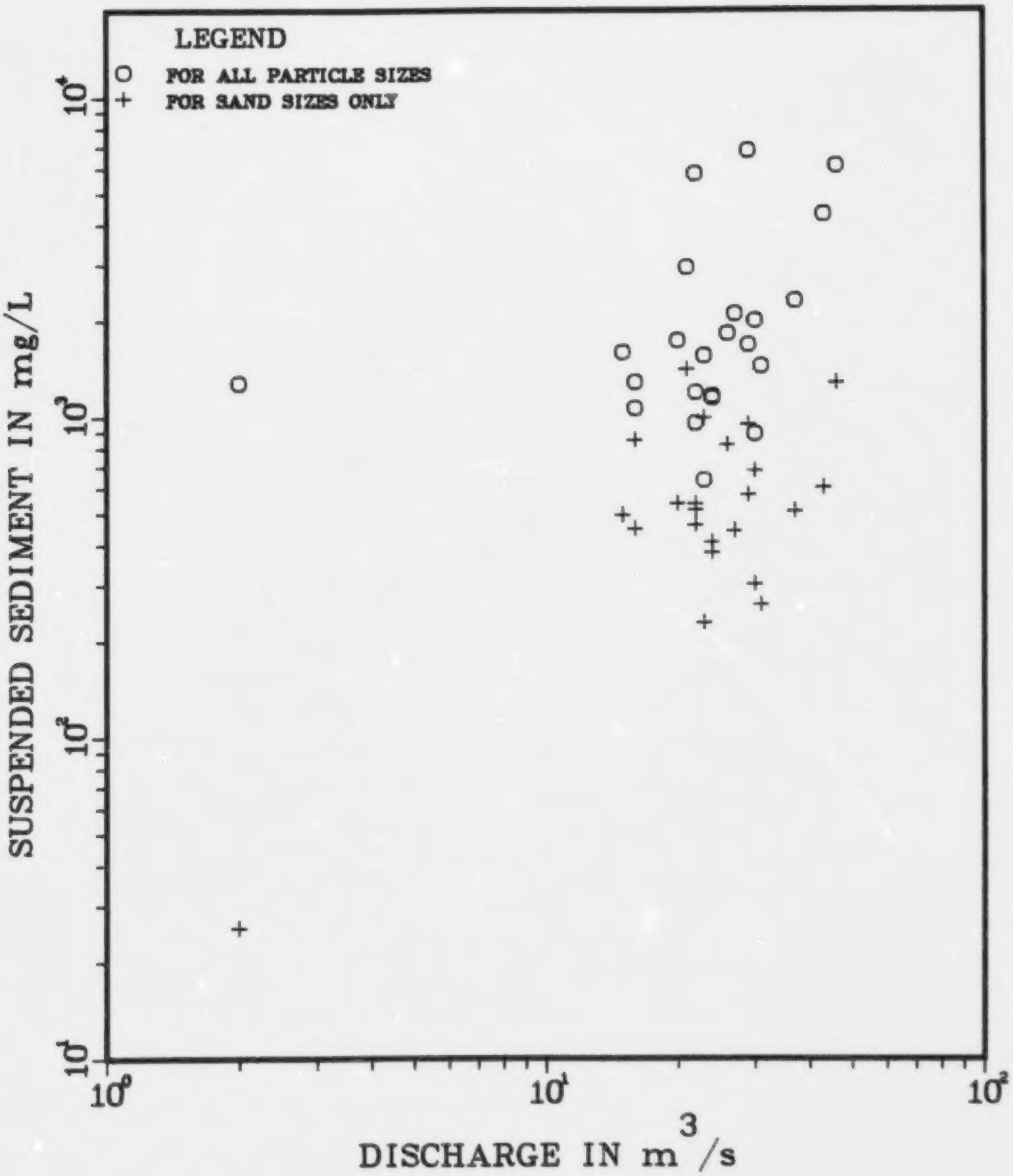


Figure G-14

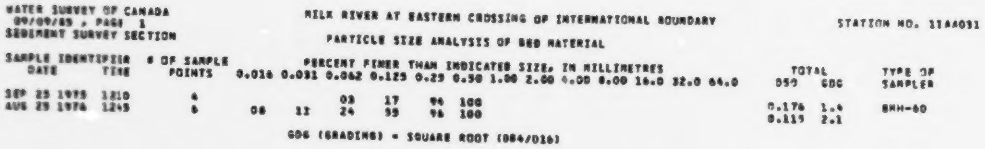
Variation of Concentration with Discharge
Showing the Sand Component of the Suspended Sediments

5.0 BED MATERIAL DATA

Two bed material samples were taken and analyzed during the period of record. The data is contained in Table G-7 and depicted in Figure G-15.

TABLE G-7

PARTICLE SIZE ANALYSIS OF BED MATERIAL



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WATER SURVEY OF CANADA
 09/09/85 , PAGE  1                 MILK RIVER AT EASTERN CROSSING OF INTERNATIONAL BOUNDARY                STATION NO. 11AA031
SEDIMENT SURVEY SECTION                     PARTICLE SIZE ANALYSIS OF BED MATERIAL

SAMPLE IDENTIFIER  # OF SAMPLE           PERCENT FINER THAN INDICATED SIZE, IN MILLIMETRES                    TOTAL        TYPE OF
   DATE      TIME     POINTS   0.016 0.031 0.062 0.125 0.25 0.50 1.00 2.00 4.00 8.00 16.0 32.0 64.0     D50   GDG      SAMPLER

SEP 25 1975  1210       4                  03    17    94   100
AUG 25 1976  1245       6       08    12   24    55    96   100                                       0.176  1.4      BMH-60
                                                                                                        0.115  2.1
                              GDG (GRADING) = SQUARE ROOT (D84/D16)
```

6.0 BED LOAD DISCHARGE DATA

Three bed load measurements were made in 1976 using a Helly-Smith sampler; each time, individual samples were taken at the 20 percent flow interval verticals and then totalled for the entire cross-section. Table G-8 lists the results of these measurements, extended over a one-day period, and also lists the streamflow discharge at the time of the measurement, as well as the suspended sediment discharge for the same days.

The data in this table indicates that bed load discharge is a very small percentage (less than 5%) of the total sediment discharge.

TABLE G-8

MILK RIVER AT EASTERN CROSSING

BED LOAD DISCHARGE

Date 1976	Streamflow Discharge m^3/s	Bed Load Discharge Tonnes/Day	Suspended Sediment Discharge Tonnes/Day	Percent Bed Load/ Suspended Load
July 14	22.1	50	2080	2.4
August 25	20.0	80	2010	4.0
August 26	18.0	45	2250	2.0

MILK RIVER AT EASTERN CROSSING OF INTERNATIONAL BOUNDARY

STATION NO. 11AA031

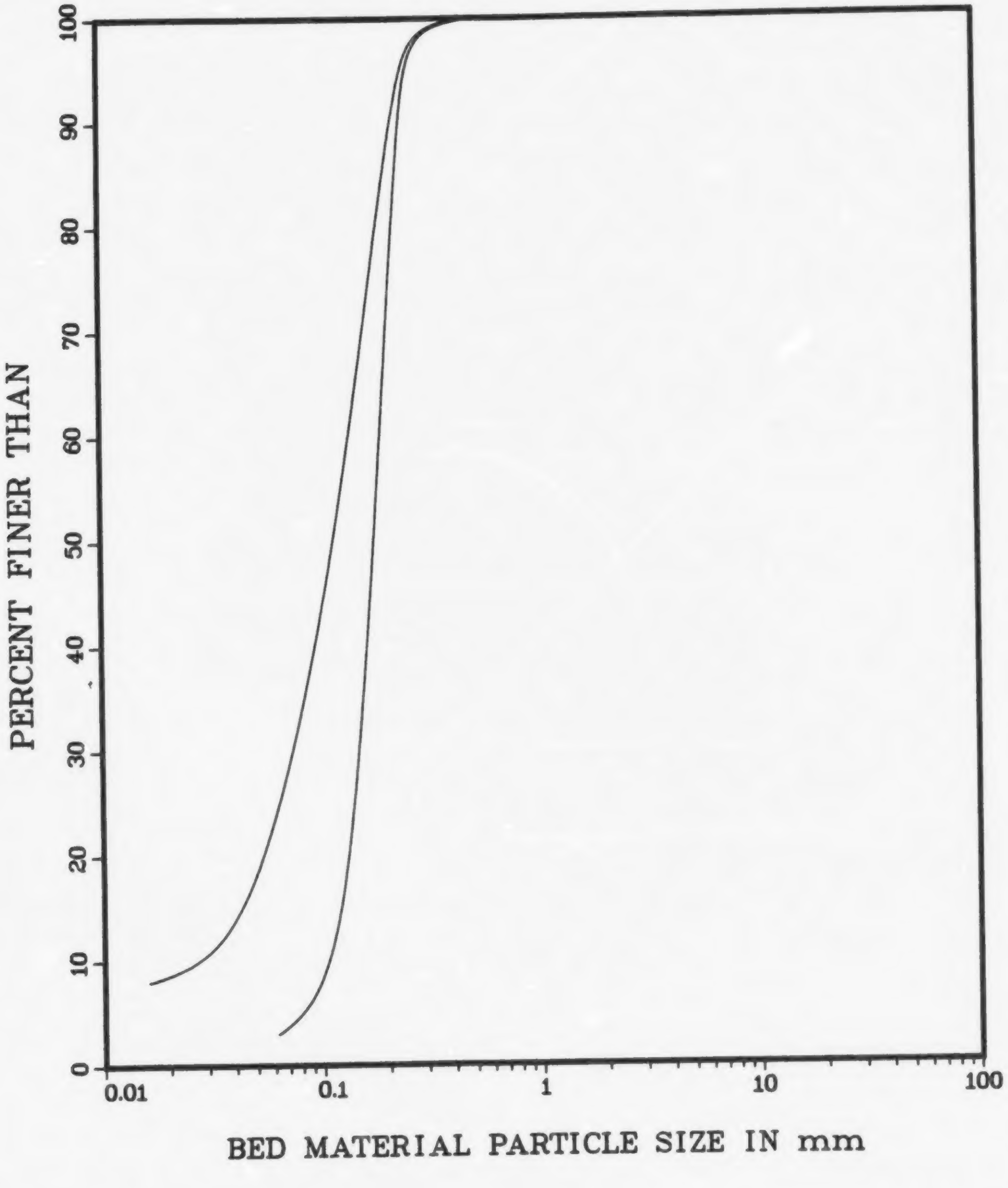


Figure G-15

Bed Material Particle Size Distribution

7.0 DISSOLVED SOLIDS DATA

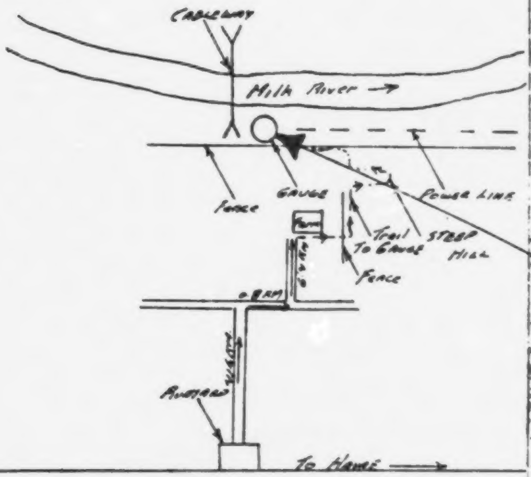
Information on dissolved solids is available as a by-product of the laboratory analyses for either suspended sediment concentration or for particle size determination. These data are contained in tabular form and are found on pages G-37 to G-45.

WATER SURVEY OF CANADA - CALGARY

STATION DESCRIPTION

DETAILED SKETCH OF STATION LOCATION

Scale= *Not to scale*


CABLEWAY
Milk River →
Fence
GAUGE
POWER LINE
Trail To GAUGE
STEEP HILL
FENCE
0.8 KM
RUDYARD
To HAVRE →

Lower intake - 0.076m diam. 11m long. Static tube.
Elevation: 1.372
Middle intake- 0.064m diam. 10.7m long.
Elevation: 1.951
Upper intake - 0.051 diam. 10.1m long.
Elevation: 2.253

ORIGINAL

STATION DESCRIPTION

Station No. 11AA031 Basin ________

Station Name Milk River at Eastern Crossing

Located in NW 1/4 Sec. 7 Tp. 37 Rge. 10 E.P.

Latitude 48°59'03" Longitude 110°28'10"

Established Sept.20/69 by U.S.G.S.

Name of Observer Ex-observer: John Wendland

Address North Route #39, Rudyard MT 59540

Rate of Pay ________ Freq. of Obs. ________

Phone: 299-5336

Location of station with respect to towns, etc:

From Rudyard, go north 41.6 km east - 0.8 km, north - 6.4 km and follow trail to gauge.

Description of gauge and equipment:

Recorder housed in metal shelter over 1.5 diam. corrugated aluminum culvert pipe well.

0 - 6.096 I.G.

Power with 2 Fisher porter punch tapes for W.L and temperature. Telemark (299-5333)

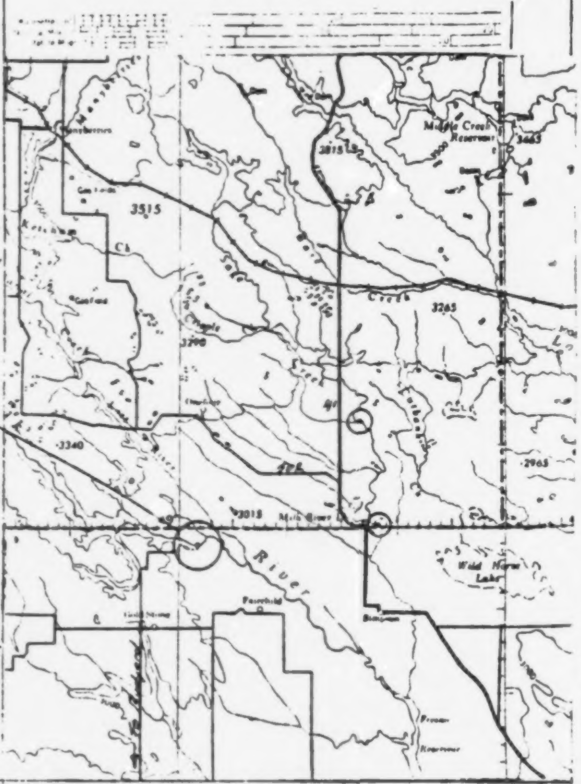
Measurement description: (Do not drive downhill when wet)

High water measurements from cableway 20m above gauge. I.P. large mark on RB cable 4 ft. intervals. Double marks at 20 ft. intervals. Triple marks at 100 ft. intervals. Wading to about 6.0 ft gauge height. About 15.2m-76.2m upstream or downstream of cableway.

Prepared by: RGH Date: October 20/83.

SKETCH OF STATION LOCATION

Scale= *1:500,000*


Middle Creek Reservoir
3465
3515
Ch
Creek
3265
3290
3340
2965
3015
Milk River
River
Wild Horse Lake

BENCH MARKS

Give elevation of bench marks, type, and number or markings, and gauge datum.

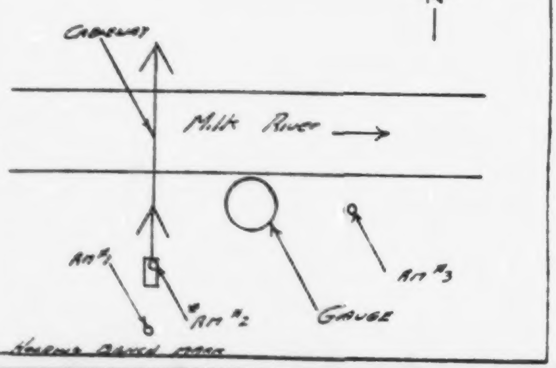
Gauge Datum= 0.000

RM #1 - Standard bonze tablet in top of right bank gravity type concrete cable anchorage.
Elevation: 8.932

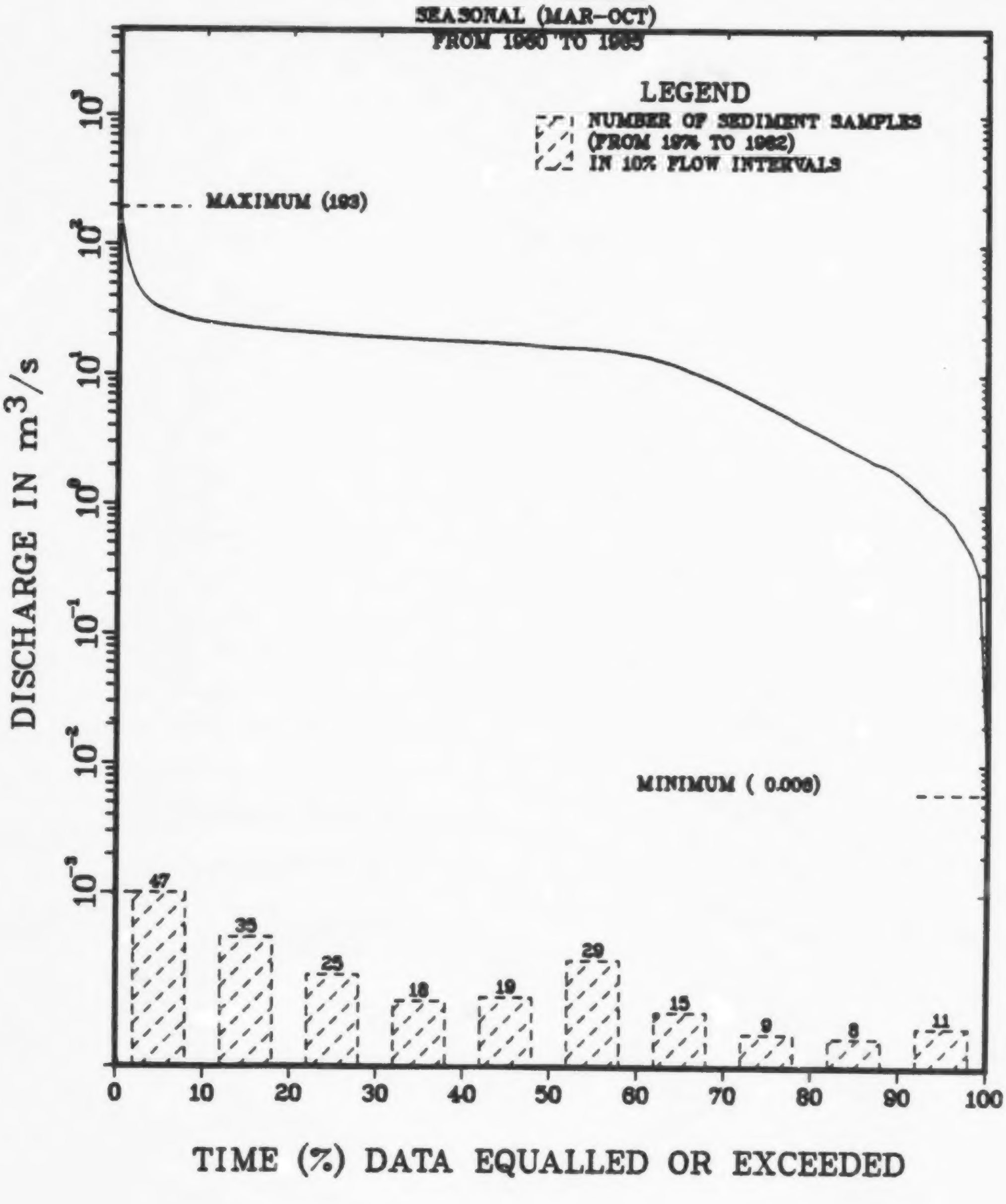
RM#2 - Standard bronze tablet in top of right bank concrete cable pedestal.
Elevation: 8.571

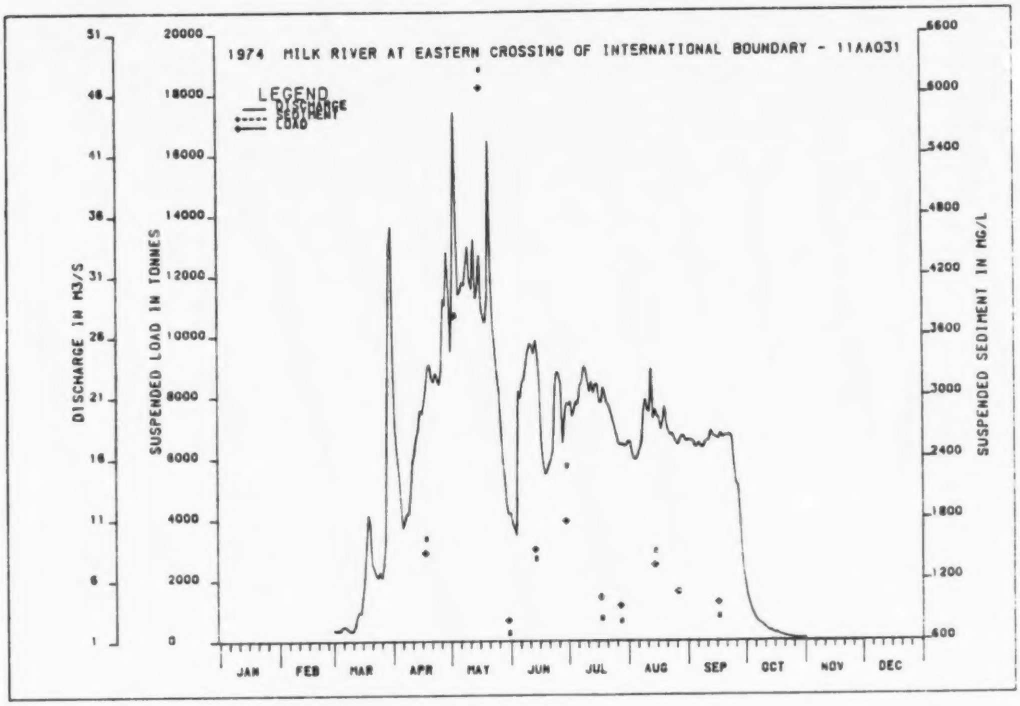
RM#3 - Top of 2.134m steel fence post. Driven 1.981m into ground. 8.534m downstream and 3.658m shoreward from gauge.
Elevation: 7.922

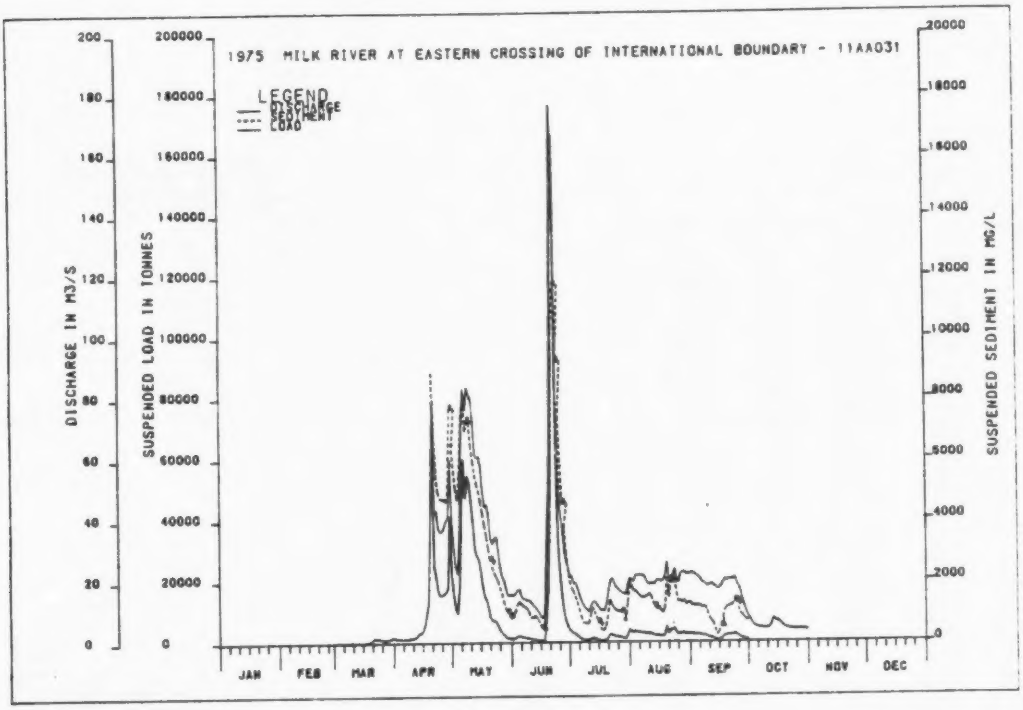
SKETCH OF BENCH MARKS

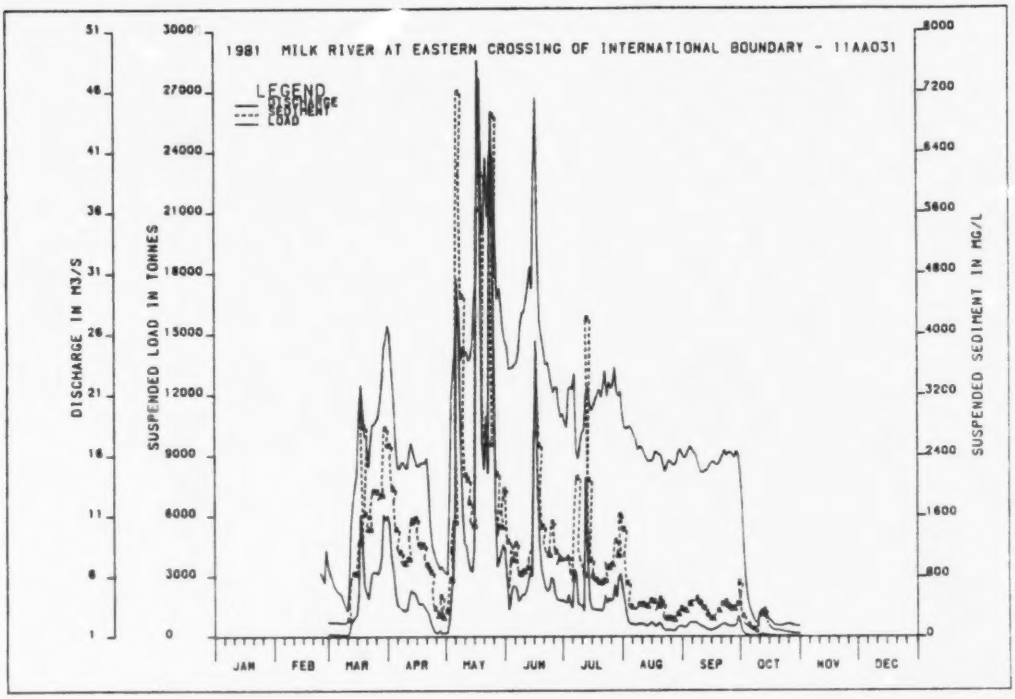

CABLEWAY
Milk River →
RM #1
RM #2
GAUGE
RM #3

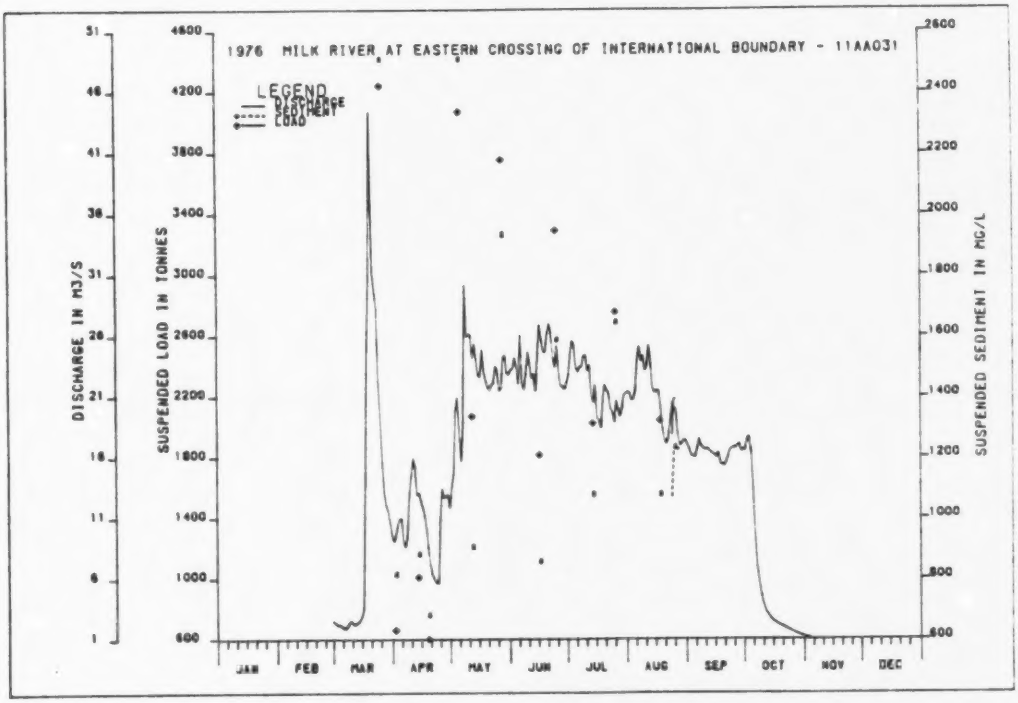
MILK RIVER AT EASTERN CROSSING OF INTERNATIONAL BOUNDARY

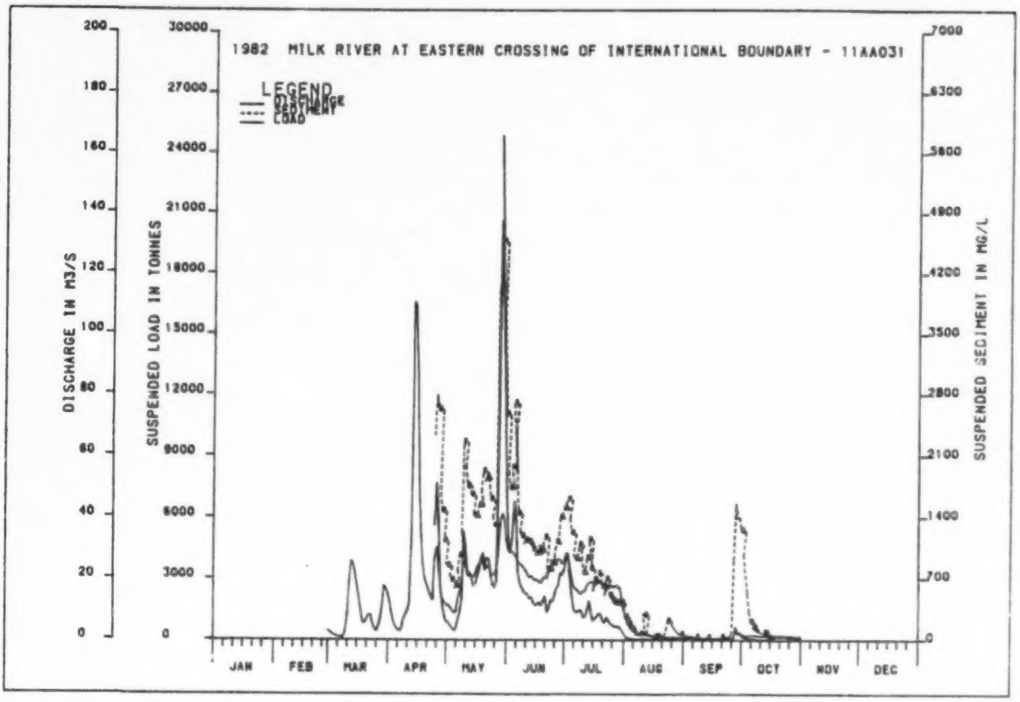



1974 MILK RIVER AT EASTERN CROSSING OF INTERNATIONAL BOUNDARY - 11AA031
LEGEND
DISCHARGE
SEDIMENT
LOAD
DISCHARGE IN M3/S
51
46
41
36
31
26
21
16
11
6
1
SUSPENDED LOAD IN TONNES
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
SUSPENDED SEDIMENT IN MG/L
6600
6000
5400
4800
4200
3600
3000
2400
1800
1200
600
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC


1975 MILK RIVER AT EASTERN CROSSING OF INTERNATIONAL BOUNDARY - 11AA031
LEGEND
DISCHARGE
SEDIMENT
LOAD
DISCHARGE IN M3/S
200
180
160
140
120
100
80
60
40
20
0
SUSPENDED LOAD IN TONNES
200000
180000
160000
140000
120000
100000
80000
60000
40000
20000
0
SUSPENDED SEDIMENT IN MG/L
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC


1981 MILK RIVER AT EASTERN CROSSING OF INTERNATIONAL BOUNDARY - 11AA031
LEGEND
DISCHARGE
SEDIMENT
LOAD
DISCHARGE IN M3/S
SUSPENDED LOAD IN TONNES
SUSPENDED SEDIMENT IN MG/L
1
6
11
16
21
26
31
36
41
46
51
0
3000
6000
9000
12000
15000
18000
21000
24000
27000
30000
0
800
1600
2400
3200
4000
4800
5600
6400
7200
8000
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC


1976 MILK RIVER AT EASTERN CROSSING OF INTERNATIONAL BOUNDARY - 11AA031
LEGEND
DISCHARGE
SEDIMENT
LOAD
DISCHARGE IN M3/S
SUSPENDED LOAD IN TONNES
SUSPENDED SEDIMENT IN MG/L
1
6
11
16
21
26
31
36
41
46
51
600
1000
1400
1800
2200
2600
3000
3400
3800
4200
4600
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC


1982 MILK RIVER AT EASTERN CROSSING OF INTERNATIONAL BOUNDARY - 11AA031
LEGEND
DISCHARGE
SEDIMENT
LOAD
DISCHARGE IN M3/S
0
20
40
60
80
100
120
140
160
180
200
SUSPENDED LOAD IN TONNES
0
3000
6000
9000
12000
15000
18000
21000
24000
27000
30000
SUSPENDED SEDIMENT IN MG/L
0
700
1400
2100
2800
3500
4200
4900
5600
6300
7000
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC

MILK RIVER AT EASTERN CROSSING OF INTERNATIONAL BOUNDARY

MONTH	DAY	TIME	DISSOLVED SOLIDS (mg/L)	INSTANTANEOUS CONCENTRATION (mg/L)	DISCHARGE (m^3/s)
INSTANTANEOUS DATA FOR 1974					
APR	17		173	2290 M	21.5
APR	17			1791 M	21.5
APR	17			1458 M	21.5
APR	17			1613 M	21.5
APR	17			1383 M	21.5
APR	17			1252 M	21.5
MAY	2	1545	157	3918	34.8
MAY	16	1155	232	6373	33.7
MAY	16	1205		6635	33.7
MAY	16	1215		6553	33.7
MAY	16			6466	33.7
MAY	16	1240		6251	33.7
MAY	16	1245		6613	33.7
MAY	30	1800	189	659	12.1
JUN	13	1045	161	1421	25.7
JUN	29	1230	146	2373	20.3
JUL	17	1700	109	808	21.2
JUL	27	1150	113	778	18.1
AUG	14	1820	123	1499	20.1
AUG	26	1900	100	1082	17.5
SEP	16	1719	100	829	18.7
INSTANTANEOUS DATA FOR 1975					
APR	21	1900	225	8690	56.1
APR	30	0955	294	8294	72.2
MAY	9	1215	321	7532	86.6
MAY	21	1420	263	2727	34.5
MAY	30	1140	303	969	16.1
JUN	17	2010	327	397	8.30
JUN	23	1100	325	12322	174
JUN	24	1930	307	8975	64.6
JUN	27	1250	370	4680	39.4
JUL	16	1700	337	536	11.6
JUL	28	1530	200	966	17.1
AUG	14	1145	147	1129	20.1
AUG	23	1340	150	1967	22.7
SEP	17	1100	130	450	19.4
SEP	24	1015	131	1363	21.9
SEP	25	1130	132	845 M	20.6

MILK RIVER AT EASTERN CROSSING OF INTERNATIONAL BOUNDARY

MONTH	DAY	TIME	DISSOLVED SOLIDS (mg/L)	INSTANTANEOUS CONCENTRATION (mg/L)	DISCHARGE (m^3/s)
INSTANTANEOUS DATA FOR 1974 (cont'd.)					
SEP	25			1415 M	20.6
SEP	25			1274 M	20.6
SEP	25			956 M	20.6
SEP	25			813 M	20.6
SEP	25	1150		529 M	20.6
INSTANTANEOUS DATA FOR 1976					
MAR	26	1210	255	2584	17.5
APR	2	1830	256	816	9.80
APR	14	1030	276	886	14.0
APR	19	1740	291	675	9.88
MAY	6	1420	331	2577	18.4
MAY	12	1420	273	911	27.0
MAY	28	1430	180	1978	23.2
JUN	16	1435	156	860	26.1
JUN	25	1120	161	1618	23.9
JUL	14	1300	137	860 M	21.9
JUL	14			1273 M	21.9
JUL	14			1243 M	21.9
JUL	14			1360 M	21.9
JUL	14			1123 M	21.9
JUL	14	1320		950 M	21.9
JUL	26	1440	133	1086	19.8
AUG	18	0950	128	1679	22.4
AUG	25	1130	137	1271 M	21.7
AUG	25			1169 M	21.7
AUG	25			835 M	21.7
AUG	25			905 M	21.7
AUG	25			1180 M	21.7
AUG	25	1130		619 M	21.7
AUG	26	0935	115	1248	21.0
INSTANTANEOUS DATA FOR 1981					
MAR	11	1145	365	159	2.97
MAR	14	1200	293	695	12.6
MAR	17	1220	196	900	20.2
MAR	19	1415	138	2232 M	20.9

MILK RIVER AT EASTERN CROSSING OF INTERNATIONAL BOUNDARY

MONTH	DAY	TIME	DISSOLVED SOLIDS (mg/L)	INSTANTANEOUS CONCENTRATION (mg/L)	DISCHARGE (m^3/s)
		INSTANTANEOUS DATA FOR 1981 (cont'd.)			
MAR	19	1425		2052 M	20.9
MAR	19	1430		5238 M	20.9
MAR	19	1435		2817 M	20.9
MAR	19	1440		2658 M	20.9
MAR	19	1505		2374 M	20.9
MAR	20	1045	180	1215	17.9
MAR	22	0920	175	1170	16.9
MAR	24	1400	166	1663	19.4
MAR	26	1240	284	1737	20.0
MAR	28	0950	181	1595	21.6
MAR	30	1445	205	2876	26.2
APR	1	1440	228	2168 M	27.0
APR	1	1445		2361 M	27.0
APR	1	1450		2656 M	27.0
APR	1	1455		3197 M	27.0
APR	1	1500		2566 M	27.0
APR	1	1605		2258 M	27.0
APR	3	1435	230	1748	19.2
APR	5	1030	200	1348	18.1
APR	7	1315	237	850 M	15.7
APR	7			952 M	15.7
APR	7			1181 M	15.7
APR	7			1163 M	15.7
APR	7			1444 M	15.7
APR	7	1400		1070 M	15.7
APR	9	1615	201	956	16.1
APR	11	1330	181	1002	15.7
APR	13	0900	176	1288	17.7
APR	15	1320	172	1042	17.5
APR	17	1225	168	888 M	15.9
APR	17	1230		1468 M	15.9
APR	17	1235		1458 M	15.9
APR	17	1250		1288 M	15.9
APR	17	1255		920 M	15.9
APR	17	1315		728 M	15.9
APR	19	0915	170	789	16.5
APR	21	1330	185	700	16.5
APR	23	1430	203	747	10.3
APR	25	1320	255	318	8.27
APR	27	1255	271	239	7.42

MILK RIVER AT EASTERN CROSSING OF INTERNATIONAL BOUNDARY

MONTH	DAY	TIME	DISSOLVED SOLIDS (mg/L)	INSTANTANEOUS CONCENTRATION (mg/L)	DISCHARGE (m^3/s)
		INSTANTANEOUS DATA FOR 1981 (cont'd.)			
APR	28	1445	285	400 M	6.78
APR	28			476 M	6.78
APR	28			456 M	6.78
APR	28			368 M	6.78
APR	28			289 M	6.78
APR	28	1510		211 M	6.78
APR	29	1300	286	190	7.05
MAY	1	1315	294	293	6.51
MAY	3	1520	288	834	16.3
MAY	5	1350	184	1391	23.5
MAY	7	0810	275	6642	26.8
MAY	7	0810	–	6805	26.8
MAY	9	1420	228	4059	23.5
MAY	9	1420	–	3923	23.5
MAY	11	1745	256	1839	24.7
MAY	12	0945	227	1837 M	25.3
MAY	12	1015		2145 M	25.3
MAY	12			2262 M	25.3
MAY	12			3131 M	25.3
MAY	12			1732 M	25.3
MAY	12	1000		1657 M	25.3
MAY	13	1740	249	1456	23.7
MAY	15	1650	238	1269	26.0
MAY	17	1155	291	7677	30.3
MAY	17	1155	–	7393	30.3
MAY	19	0910	386	4607 M	45.3
MAY	19	0910		4566 M	45.3
MAY	19	1420		5672 M	45.3
MAY	19	1420		5579 M	45.3
MAY	19	1425		5996 M	45.3
MAY	19	1427		6054 M	45.3
MAY	19	1429		6125 M	45.3
MAY	19	1429		6053 M	45.3
MAY	19	1433		6242 M	45.3
MAY	19	1435		6471 M	45.3
MAY	19	1438		6440 M	45.3
MAY	19	1449		6516 M	45.3
MAY	19	1442		6987 M	45.3
MAY	19	1443		6323 M	45.3
MAY	19	1504		5359 M	45.3
MAY	19	1506		5438 M	45.3

MILK RIVER AT EASTERN CROSSING OF INTERNATIONAL BOUNDARY

MONTH	DAY	TIME	DISSOLVED SOLIDS (mg/L)	INSTANTANEOUS CONCENTRATION (mg/L)	DISCHARGE (m^3/s)
INSTANTANEOUS DATA FOR 1981 (cont'd.)					
MAY	21	1715	295	2457	36.8
MAY	23	1435	300	2316	35.4
MAY	25	1715	312	5967	43.3
MAY	27	0920	291	2124	33.7
MAY	27	2040	-	1610	30.3
MAY	29	1425	263	1448	31.1
MAY	31	0837	243	1840	27.3
JUN	2	2030	214	898	24.7
JUN	4	1320	206	1066	24.2
JUN	4	2045	203	1155	23.5
JUN	6	0925	203	1173	25.0
JUN	8	1314	199	754	25.5
JUN	10	1330	185	856	26.5
JUN	12	1230	174	891	30.3
JUN	16	1445	170	2376	40.2
JUN	16	1445	208	3800	40.2
JUN	18	1305	270	2505 M	33.1
JUN	18	1305		2438 M	33.1
JUN	18	1555		2401 M	33.1
JUN	18	1559		2538 M	33.1
JUN	18	1602		2972 M	33.1
JUN	18	1605		2539 M	33.1
JUN	18	1608		2327 M	33.1
JUN	20	1210	267	1365	27.3
JUN	20	1210	-	1458	27.3
JUN	23	1725	205	1063	24.5
JUN	25	1240	193	1564	22.8
JUN	27	1703	173	1021	22.3
JUN	29	0833	170	1039	20.8
JUL	3	2120	167	1139	19.4
JUL	5	0715	160	853	22.5
JUL	8	1030	184	2140	16.1
JUL	12	1535	143	756	19.2
JUL	13	1645	212	5783	22.3
JUL	14	2151	161	1342	22.1
JUL	15	1400	166	923	19.2
JUL	16	1907	160	763	20.4
JUL	18	1110	149	723	21.4
JUL	20	1303	142	675	22.3
JUL	22	2145	144	638	23.7
JUL	24	1210	143	571	21.4

MILK RIVER AT EASTERN CROSSING OF INTERNATIONAL BOUNDARY

MONTH	DAY	TIME	DISSOLVED SOLIDS (mg/L)	INSTANTANEOUS CONCENTRATION (mg/L)	DISCHARGE (m^3/s)
		INSTANTANEOUS DATA FOR 1981 (cont'd.)			
JUL	26	1243	129	542	23.0
JUL	28	1725	129	751	25.7
JUL	29	1010	130	800 M	22.1
JUL	29	1020		1025 M	22.1
JUL	29	1030		1056 M	22.1
JUL	29	1045		1072 M	22.1
JUL	29	1055		856 M	22.1
JUL	29	1120		484 M	22.1
JUL	29	1245		515 M	22.1
JUL	29	1245		531 M	22.1
JUL	30	1149	134	861	21.6
AUG	1	2121	154	1138	19.6
AUG	3	2226	125	498	19.2
AUG	5	1418	127	368	19.4
AUG	9	2224	129	442	17.1
AUG	11	2241	124	426	17.3
AUG	13	2142	123	384	15.9
AUG	15	2145	133	529	16.1
AUG	17	2159	128	390	16.5
AUG	19	2100	125	424	16.1
AUG	20	1500	128	424 M	16.6
AUG	20	1500		534 M	16.6
AUG	20	1500		730 M	16.6
AUG	20	1500		450 M	16.6
AUG	20	1500		463 M	16.6
AUG	21	2217	125	340	16.7
AUG	23	2155	133	219	15.0
AUG	25	2140	128	236	15.9
AUG	27	2156	131	207	15.7
AUG	29	2024	128	350	15.9
AUG	31	2023	121	382	17.1
SEP	2	2005	125	343	16.5
SEP	4	2018	127	497	17.5
SEP	8	1946	119	540	16.5
SEP	10	1705	126	442	15.4
SEP	12	0823	123	399	15.2
SEP	14	1923	115	260	15.4
SEP	16	2040	116	250	16.1
SEP	19	1654	116	371	15.9
SEP	21	2103	186	494	16.3
SEP	23	1943	143	495	16.7

MILK RIVER AT EASTERN CROSSING OF INTERNATIONAL BOUNDARY

MONTH	DAY	TIME	DISSOLVED SOLIDS (mg/L)	INSTANTANEOUS CONCENTRATION (mg/L)	DISCHARGE (m^3/s)
INSTANTANEOUS DATA FOR 1981 (cont'd.)					
SEP	25	1728	123	403	17.1
SEP	27	0824	118	399	16.7
SEP	29	1649	115	464	16.7
SEP	30	1450	119	400 M	16.5
SEP	30	1450		383 M	16.5
SEP	30	1455		1293 M	16.5
SEP	30	1455		1054 M	16.5
SEP	30	1500		763 M	16.5
SEP	30	1500		745 M	16.5
SEP	30	1505		746 M	16.5
SEP	30	1505		823 M	16.5
SEP	30	1510		788 M	16.5
SEP	30	1510		619 M	16.5
SEP	30	1525		845 M	16.5
OCT	2	1122	123	249	12.6
OCT	5	1115	148	136	3.51
OCT	8	2027	205	64	2.34
OCT	11	1045	242	323	3.60
OCT	13	1655	287	355 M	3.23
OCT	13	1700		377 M	3.23
OCT	13	1705		360 M	3.23
OCT	13	1708		277 M	3.23
OCT	13	1710		317 M	3.23
INSTANTANEOUS DATA FOR 1982					
APR	27	1204	237	2337	24.0
APR	29	1100	230	1085 M	14.5
APR	29	1110		1563 M	14.5
APR	29	1115		1780 M	14.5
APR	29	1120		1595 M	14.5
APR	29	1130		1770 M	14.5
APR	29	1155		1282 M	14.5
APR	30	1355	270	901	12.7
MAY	2	2100	329	653	12.3
MAY	4	2058	346	536	11.2
MAY	6	1815	357	537	11.6
MAY	8	1011	337	844	17.5
MAY	10	1021	301	2106	26.2
MAY	12	1722	256	2520	21.4

MILK RIVER AT EASTERN CROSSING OF INTERNATIONAL BOUNDARY

MONTH	DAY	TIME	DISSOLVED SOLIDS (mg/L)	INSTANTANEOUS CONCENTRATION (mg/L)	DISCHARGE (m^3/s)
		INSTANTANEOUS DATA FOR 1982 (cont'd.)			
MAY	14	1015	230	1483	21.8
MAY	16	1642	218	1258	22.3
MAY	18	1236	201	1381	26.2
MAY	20	1036	194	1834	25.7
MAY	22	2119	185	1706	25.5
MAY	24	1305	186	1472	24.2
MAY	26	1307	174	1215	24.7
MAY	28	1449	216	4452	34.0
MAY	30	1454	258	4317	37.7
JUN	1	1131	293	2461	31.4
JUN	3	0847	377	1675	25.2
JUN	4	0725	346	2001 M	30.0
JUN	4	0730		1941 M	30.0
JUN	4	0735		2281 M	30.0
JUN	4	0740		1883 M	30.0
JUN	4	0745		1851 M	30.0
JUN	4	0830		1951 M	30.0
JUN	5	2017	311	3268	27.8
JUN	7	1640	280	1344	26.0
JUN	9	2127	258	1143	24.5
JUN	11	1903	281	1153	23.0
JUN	13	0733	278	1132	20.9
JUN	15	2038	250	1011	20.9
JUN	17	1030	239	949	20.0
JUN	17	2126	-	1147	20.0
JUN	19	1308	233	1059	19.4
JUN	21	1334	221	1288	21.6
JUN	23	1949	204	933	24.2
JUN	25	2200	177	909	26.8
JUN	27	0732	150	1129	26.0
JUN	29	1458	179	1566	27.0
JUL	1	1919	173	1554	26.8
JUL	3	0806	166	1694	30.6
JUL	5	2013	223	1122	18.9
JUL	7	2037	198	935	16.5
JUL	9	2141	166	1188	16.1
JUL	11	0817	164	733	16.1
JUL	13	2025	152	1039	19.4
JUL	14	1818	151	2641 M	19.3
JUL	14	1826		922 M	19.3
JUL	14	1832		875 M	19.3

MILK RIVER AT EASTERN CROSSING OF INTERNATIONAL BOUNDARY

MONTH	DAY	TIME	DISSOLVED SOLIDS (mg/L)	INSTANTANEOUS CONCENTRATION (mg/L)	DISCHARGE (m^3/s)
INSTANTANEOUS DATA FOR 1982 (cont'd.)					
JUL	14	1840		1019 M	19.3
JUL	14	1848		866 M	19.3
JUL	14	1917		1242 M	19.3
JUL	15	2138	151	539	19.2
JUL	17	0850	153	698	18.3
JUL	19	2058	135	822	20.0
JUL	21	2059	132	495	19.2
JUL	23	1812	131	789	18.9
JUL	25	2208	133	532	17.9
JUL	27	2131	123	432	18.0
JUL	29	2312	133	424	19.2
JUL	31	1811	129	421	13.6
AUG	2	1549	141	227	7.87
AUG	4	2121	172	163	4.39
AUG	6	2116	204	80	3.09
AUG	10	1120	296	44	1.76
AUG	17	1802	415	21	1.13
AUG	19	0840	435	27	0.889
AUG	24	1910	495	245	0.869
AUG	31	0915	520	45	0.668
AUG	31	2235	528	54	0.677
SEP	8	0755	569	16	0.442
SEP	14	1556	609	12	0.314
SEP	21	2008	634	20	0.297
OCT	6	1300	529	185	1.33
OCT	8	1708	519	118	1.45
OCT	13	1747	532	68	1.25
OCT	14	0920	524	60	1.21

M - MEASUREMENT

ALBERTA

MILK RIVER AT EASTERN CROSSING OF INTERNATIONAL BOUNDARY - STATION NO. 11AA031

SUSPENDED SEDIMENT FOR 1975

DAY	JAN				FEB				MAR				DAY
	TEMP. (C)	DAILY DISCHARGE (CFS)	MEAN CON-CENTRATION (MG/L)	TONS PER DAY	TEMP. (C)	DAILY DISCHARGE (CFS)	MEAN CON-CENTRATION (MG/L)	TONS PER DAY	TEMP. (C)	DAILY DISCHARGE (CFS)	MEAN CON-CENTRATION (MG/L)	TONS PER DAY	
1										0 B			1
2										0 B			2
3										0 B			3
4										0 B			4
5										0 B			5
6										0 B			6
7										0 B			7
8										0 B			8
9										0 B			9
10										0 B			10
11										0 B			11
12										0 B			12
13										0 B			13
14										0 B			14
15										0 B			15
16										0 B			16
17										0 B			17
18										2.0			18
19										8.0 B			19
20										23 B			20
21										36 B			21
22										60 B			22
23										49 B			23
24										49 B			24
25										44 B			25
26										33 B			26
27										31 B			27
28										31 B			28
29										34 B			29
30										46 B			30
31										60 B			31
TOTAL										506.0			TOTAL
MEAN										16.3			MEAN

DAY	APR				MAY				JUN				DAY
	TEMP. (C)	DAILY DISCHARGE (CFS)	MEAN CON-CENTRATION (MG/L)	TONS PER DAY	TEMP. (C)	DAILY DISCHARGE (CFS)	MEAN CON-CENTRATION (MG/L)	TONS PER DAY	TEMP. (C)	DAILY DISCHARGE (CFS)	MEAN CON-CENTRATION (MG/L)	TONS PER DAY	
1		57 B				1430	6570	25400		576	823	1280	1
2		51 B				1140	5860	18000		560	866	1310	2
3		44 B				910	5260	12900		592	1030	1650	3
4		42 B				835	4880	11000		634	1300	2230	4
5		42 B				1320	5750	20500		634	1390	2380	5
6		38 B				2510	7690	52100		552	1300	1940	6
7		42 B				3070	8320	69000		519	1230	1720	7
8		39 B				2800	7240	54700		519	1200	1680	8
9		55 B			9.0	3080	7560 S	62900		503	1140	1550	9
10		53 B				2980	7510	60400		503	1010	1370	10
11		53 B				2940	6720	53300		480	839	1090	11
12		62 B				2680	6170	44600		444	818	981	12
13		80 B				2260	5730	35000		423	895	1020	13
14		117 B				2230	5420	32600		397	846	907	14
15		115 B				2240	5170	31300		358	743	718	15
16		139 B				2120	4790	27400		311	587	493	16
17		216 B				1830	4390	21700	13.0	285	446 S	343	17
18		340 B				1630	3990	17600		321	405	351	18
19		486 B				1660	3590	16100		1260	2860	9730	19
20		1450 B				1530	3180	13100		1860	4300	21600	20
21		2900 B	9200 S	72000	10.0	1260	2790 S	9490		3730	6260	63000	21
22		1540	6880	28600		1190	2570	8260		6490	10800	189000	22
23		1590	5720	24600		1260	2370	8060	16.0	5810	12200 S	191000	23
24		1370	5140	19000		1280	2230	7710	21.0	2720	9600 S	70500	24
25		1330	4900	17600		1110	2090	6260		1890	7670	39100	25
26		1350	4880	17800		898	1870	4530		1580	6040	25800	26
27		1390	4890	18400		790	1660	3540	16.0	1400	4730 S	17900	27
28		1470	4800	19100		746	1400	2820		1120	3840	11600	28
29		1500	5070	20500		639	1170	2020		979	3070	8110	29
30	5.0	2200	7980 S	47400	15.0	565	1000 S	1530		887	2540	6080	30
31						568	918	1410					31
TOTAL		20161				51501		735230		38337		676433	TOTAL
MEAN		672				1660		23700		1280		22500	MEAN

MILK RIVER AT EASTERN CROSSING OF INTERNATIONAL BOUNDARY - STATION NO. 11AA031

SUSPENDED SEDIMENT FOR 1975

	JUL				AUG				SEP				
DAY	TEMP. (C)	DAILY DISCHARGE (CFS)	MEAN CONCENTRATION (MG/L)	TONS PER DAY	TEMP. (C)	DAILY DISCHARGE (CFS)	MEAN CONCENTRATION (MG/L)	TONS PER DAY	TEMP. (C)	DAILY DISCHARGE (CFS)	MEAN CONCENTRATION (MG/L)	TONS PER DAY	DAY
1		799	2080	4490		774	2150	4490		828	1330	2970	1
2		789	1840	3920		724	1860	3640		818	1250	2760	2
3		706	1710	3260		738	1730	3450		818	1240	2740	3
4		706	1540	2940		808	1740	3800		799	1220	2630	4
5		682	1350	2340		795	1650	3540		780	1230	2590	5
6		568	1130	1730		808	1570	3430		762	1240	2550	6
7		495	861	1150		799	1510	3260		716	1180	2280	7
8		444	657	788		799	1500	3240		706	1170	2230	8
9		410	643	712		753	1530	3110		687	1170	2170	9
10		385	621	646		700	1570	2970		669	1010	1820	10
11		361	643	627		694	1650	3090		687	809	1500	11
12		430	948	1100		708	1530	2920		697	707	1330	12
13		488	1160	1530		696	1350	2540		678	639	1170	13
14		488	1000	1320	18.0	708	1160 S	2220		660	419	787	14
15		444	845	1010		753	1120	2280		634	246	421	15
16		417	627 S	706		735	1140	2260		651	307	540	16
17		379	453	464		725	1060	2070	16.0	675	490 S	893	17
18		385	402	418		744	990	1990		711	823	1580	18
19		373	397	400		789	1140	2430		747	1100	2220	19
20		451	562	684		965	2180	5680		746	1170	2360	20
21		617	1030	1720		725	1520	2980		749	1210	2450	21
22		744	1430	2870		789	2040	4350		748	1220	2460	22
23		771	1260	2620	19.0	806	2040 S	4440		756	1260	2570	23
24		697	1140	2150		878	2130	5050	12.0	773	1360 S	2840	24
25		656	1070	1900		753	1660	3370	15.0	703	1310 S	2490	25
26		633	1030	1760		725	1370	2680		660	1120	2000	26
27		607	1040	1700		828	1410	3150		601	951	1540	27
28	25.0	586	987 S	1560		837	1340	3030		499	894	1200	28
29		575	770	1200		847	1420	3250		425	805	924	29
30		572	705	1090		808	1270	2770		355	722	692	30
31		694	1360	2550		818	1330	2940					31
TOTAL		17312		51355		24029		100420		20738		56667	TOTAL
MEAN		558		1660		775		3240		691		1890	MEAN

	OCT				NOV				DEC				
DAY	TEMP. (C)	DAILY DISCHARGE (CFS)	MEAN CONCENTRATION (MG/L)	TONS PER DAY	TEMP. (C)	DAILY DISCHARGE (CFS)	MEAN CONCENTRATION (MG/L)	TONS PER DAY	TEMP. (C)	DAILY DISCHARGE (CFS)	MEAN CONCENTRATION (MG/L)	TONS PER DAY	DAY
1		301											1
2		266											2
3		220											3
4		193											4
5		176											5
6		164											6
7		161											7
8		158											8
9		155											9
10		155											10
11		154											11
12		168											12
13		201											13
14		285											14
15		247											15
16		248											16
17		229											17
18		208											18
19		184											19
20		166											20
21		156											21
22		150											22
23		150											23
24		143											24
25		140											25
26		141											26
27		147											27
28		149											28
29		143											29
30		140											30
31		136											31
TOTAL		5634											TOTAL
MEAN		182											MEAN

SUMMARY FOR THE MONTHS MAR TO OCT

SUSPENDED SEDIMENT CONCENTRATION	SUSPENDED SEDIMENT LOAD
MAXIMUM DAILY 12200 MG/L ON JUN 23	MAXIMUM DAILY 191000 TONS/DAY ON JUN 23

B - ICE CONDITIONS

S - SAMPLE(S) COLLECTED THIS DAY

SEDIMENT DATA PARTIALLY CONTRIBUTED BY UNITED STATES GEOLOGICAL SURVEY

INTERNATIONAL GAUGING STATION

TYPE OF GAUGE - RECORDING
LOCATION - LAT 48 59 05 N
LONG 110 28 15 W
DRAINAGE AREA 2630 SQ MILES
REGULATED FLOW SINCE 1917

MILK RIVER AT EASTERN CROSSING OF INTERNATIONAL BOUNDARY - STATION NO. 11AA031

SUSPENDED SEDIMENT FOR 1981

	JAN				FEB				MAR				
DAY	TEMP. (°C)	DAILY DISCHARGE (m^3/s)	MEAN CONCENTRATION (mg/L)	DAILY LOAD (t)	TEMP. (°C)	DAILY DISCHARGE (m^3/s)	MEAN CONCENTRATION (mg/L)	DAILY LOAD (t)	TEMP. (°C)	DAILY DISCHARGE (m^3/s)	MEAN CONCENTRATION (mg/L)	DAILY LOAD (t)	DAY
1										7.05 B	196	119	1
2										6.51 B	195	110	2
3										5.97 B	194	100	3
4										5.38 B	193	89.7	4
5										5.10 B	192	84.6	5
6										4.81 B	190	79.0	6
7										4.76	188	77.3	7
8										4.56	187	73.7	8
9										3.99	185	63.8	9
10										3.54	183	56.0	10
11									3.0	3.20	207 S	57.2	11
12										5.52	433	207	12
13										10.6	781	715	13
14									4.0	12.5	839 S	906	14
15										13.9	842	1 010	15
16										15.0	870	1 130	16
17									4.0	20.1	1 270 S	2 210	17
18										22.7	3 210	6 300	18
19									3.0	20.5	2 870 S	5 080	19
20									0.5	18.3	1 660 S	2 620	20
21										18.1	1 460	2 280	21
22									0.1	15.6	1 450 S	1 950	22
23										17.6	1 730	2 630	23
24									5.0	19.3	1 980 S	3 300	24
25						6.51 B				19.3	2 010	3 350	25
26						6.17 B			5.5	19.6	1 970 S	3 340	26
27						5.66 B				20.0	1 890	3 270	27
28						8.50 B			4.0	21.3	1 920 S	3 530	28
29										23.1	2 100	4 190	29
30									7.0	25.8	2 840 S	6 330	30
31										26.6	2 630	6 040	31
TOTAL										420.29		61 298.3	TOTAL
MEAN										13.6		1 980	MEAN

	APR				MAY				JUN				
DAY	TEMP. (°C)	DAILY DISCHARGE (m^3/s)	MEAN CONCENTRATION (mg/L)	DAILY LOAD (t)	TEMP. (°C)	DAILY DISCHARGE (m^3/s)	MEAN CONCENTRATION (mg/L)	DAILY LOAD (t)	TEMP. (°C)	DAILY DISCHARGE (m^3/s)	MEAN CONCENTRATION (mg/L)	DAILY LOAD (t)	DAY
1	8.0	27.8	2 610 S	6 270	14.0	6.51	321 S	181		26.4	1 970	4 490	1
2		27.0	2 490	5 810		6.37	367	202	20.0	25.9	1 280 S	2 860	2
3	6.0	23.7	2 010 S	4 120	14.0	13.1	762 S	862		24.0	683	1 420	3
4		21.3	1 860	3 420		21.7	1 200	2 250	18.0	24.1	1 030 S	2 140	4
5	4.0	17.8	1 450 S	2 230	14.0	24.0	1 550 S	3 210		24.2	1 240	2 590	5
6		15.5	1 220	1 630		26.1	2 960	6 670	16.5	24.4	1 250 S	2 640	6
7	6.0	15.5	1 130 S	1 510	8.0	28.6	7 460 S	18 400		24.6	1 150	2 440	7
8		16.0	1 040	1 440		29.4	6 350	16 100	17.0	25.5	840 S	1 850	8
9	6.5	16.0	986 S	1 360	11.0	24.8	4 650 S	9 960		27.8	835	2 010	9
10		15.6	981	1 320		25.9	2 910	6 510	16.5	28.9	878 S	2 190	10
11	6.5	15.5	1 040 S	1 390	12.0	25.3	2 200 S	4 810		28.9	868	2 170	11
12		16.9	1 350	1 970	9.0	25.5	2 130 S	4 690	16.0	30.0	923 S	2 390	12
13	3.0	17.7	1 580 S	2 420	13.0	24.7	1 820 S	3 880		31.1	1 060	2 850	13
14		16.9	1 550	2 260		25.0	1 600	3 460		32.8	1 170	3 320	14
15	10.0	16.3	1 600 S	2 250	11.0	26.1	1 500 S	3 380		30.9	1 170	3 120	15
16		15.7	1 480	2 010		30.0	1 740	4 510	15.5	41.1	2 780 S	9 870	16
17	12.0	15.7	1 240 S	1 680	8.0	31.7	5 850 S	16 000		47.3	3 730	15 200	17
18		16.0	1 210	1 670		48.4	7 110	29 700	14.0	34.5	2 610 S	7 780	18
19	8.0	16.0	1 230 S	1 700	16.3	49.0	6 330 S	26 800		28.1	1 980	4 810	19
20		16.0	1 100	1 520		35.7	3 300	10 200	16.0	26.8	1 490 S	3 450	20
21	5.0	16.4	961 S	1 360	17.0	36.5	2 740 S	8 640		25.8	1 320	2 940	21
22		14.4	950	1 180		42.2	3 040	11 100		24.4	1 200	2 530	22
23	14.0	10.8	862 S	804	19.0	37.1	2 630 S	8 430	16.5	24.6	1 100 S	2 340	23
24		8.86	646	495		42.2	5 640	20 600		23.9	1 200	2 480	24
25	14.0	8.21	358 S	254	19.5	43.9	7 140 S	27 100	17.0	22.8	1 550 S	3 050	25
26		7.59	253	166		41.1	4 500	16 000		22.0	1 530	2 910	26
27	12.0	7.22	266 S	166	19.5	34.3	2 210 S	6 550	20.0	22.5	1 140 S	2 220	27
28		6.82	523 S	308		30.0	1 400	3 630		22.4	994	1 920	28
29	12.0	7.05	235 S	143	18.5	30.9	1 490 S	3 980	16.0	20.8	1 050 S	1 890	29
30		6.71	235	136		29.4	1 700	4 320		19.9	1 070	1 840	30
31					18.5	27.4	2 000 S	4 730					31
TOTAL		452.96		52 992		922.88		286 855		816.4		103 710	TOTAL
MEAN		15.1		1 770		29.8		9 250		27.2		3 460	MEAN

MILK RIVER AT EASTERN CROSSING OF INTERNATIONAL BOUNDARY - STATION NO. 11AA031

SUSPENDED SEDIMENT FOR 1981

	JUL				AUG				SEP				
DAY	TEMP. (°C)	DAILY DISCHARGE (m³/s)	MEAN CONCENTRATION (mg/L)	DAILY LOAD (t)	TEMP. (°C)	DAILY DISCHARGE (m³/s)	MEAN CONCENTRATION (mg/L)	DAILY LOAD (t)	TEMP. (°C)	DAILY DISCHARGE (m³/s)	MEAN CONCENTRATION (mg/L)	DAILY LOAD (t)	DAY
1		20.2	1 080	1 880	22.0	20.1	1 450 S	2 520		16.7	353	509	1
2		19.4	1 070	1 790		19.0	1 140	1 870	16.5	16.4	334 S	473	2
3	24.0	19.0	1 060 S	1 740	22.0	18.9	715 S	1 170		16.5	334	476	3
4		22.3	1 120	2 160		19.1	447	738	15.5	17.0	421 S	618	4
5	21.0	22.5	853 S	1 660	22.0	19.1	382 S	630		17.4	492	740	5
6		22.3	769	1 480		18.8	380	617		17.2	488	725	6
7		23.6	1 720	3 510		18.3	386	610		16.9	493	720	7
8	14.2	16.9	2 160 S	3 150		18.0	379	589	20.5	16.7	504 S	727	8
9		16.3	1 210	1 700	23.5	17.1	415 S	613		16.1	477	664	9
10		17.6	1 070	1 630		17.4	450	677	20.5	15.5	426 S	570	10
11		18.6	997	1 600	23.5	17.3	421 S	629		15.1	399	521	11
12	24.0	18.8	823 S	1 340		16.9	418	610	16.0	15.2	363 S	477	12
13	20.0	21.9	4 350 S	8 230	22.0	16.5	395 S	563		15.3	308	407	13
14	18.0	22.5	2 130 S	4 140		16.1	389	541	18.0	15.4	265 S	353	14
15	18.0	21.0	1 030 S	1 870	24.0	16.1	464 S	645		15.7	227	308	15
16	21.5	20.5	809 S	1 430		16.1	536	746	16.5	16.0	224 S	310	16
17		20.9	784	1 420	23.5	16.3	456 S	642		16.1	259	360	17
18	20.5	21.4	755 S	1 400		17.0	354	520		15.9	294	404	18
19		21.8	723	1 360	23.0	16.8	392 S	569	17.0	15.8	332 S	453	19
20	23.0	22.3	724 S	1 390	24.5	16.7	493 S	711		15.9	376	517	20
21		21.6	712	1 330	22.5	16.6	428 S	614	12.0	16.3	421 S	593	21
22	23.0	22.5	748 S	1 450		15.9	281	386		16.7	455	657	22
23		23.9	1 030	2 130	22.5	15.2	222 S	292	12.0	17.1	456 S	674	23
24	19.5	21.7	925 S	1 730		15.7	226	307		16.6	410	588	24
25		22.9	996	1 970	22.5	16.2	228 S	319	11.0	16.9	375 S	548	25
26	19.5	22.4	971 S	1 880		16.1	217	302		16.9	359	524	26
27		22.6	993	1 940	22.0	15.8	211 S	288	7.0	16.7	362 S	522	27
28	22.5	24.2	1 290 S	2 700		15.8	201	274		16.4	378	536	28
29	21.0	22.1	1 090 S	2 080	22.0	16.0	286 S	395	11.0	17.0	425 S	624	29
30	20.0	21.7	1 640 S	3 070		16.9	352	514	11.0	16.6	721 S	1 030	30
31		22.1	1 710	3 270	17.0	17.2	362 S	538					31
TOTAL		657.5		68 430		529.0		20 439		490.0		16 628	TOTAL
MEAN		21.2		2 210		17.1		659		16.3		554	MEAN

	OCT				NOV				DEC				
DAY	TEMP. (°C)	DAILY DISCHARGE (m³/s)	MEAN CONCENTRATION (mg/L)	DAILY LOAD (t)	TEMP. (°C)	DAILY DISCHARGE (m³/s)	MEAN CONCENTRATION (mg/L)	DAILY LOAD (t)	TEMP. (°C)	DAILY DISCHARGE (m³/s)	MEAN CONCENTRATION (mg/L)	DAILY LOAD (t)	DAY
1		15.2	574	754									1
2	9.5	12.4	259 S	277									2
3		8.61	189	141									3
4		5.75	159	79.0									4
5	6.8	4.28	134 S	49.6									5
6		3.48	115	34.6									6
7		2.97	97	24.9									7
8	10.0	2.55	73 S	16.1									8
9		2.24	54	10.5									9
10		2.12	44	8.06									10
11	4.8	3.11	283 S	76.0									11
12		3.23	381	106									12
13	5.5	3.31	339 S	96.9									13
14		3.03	275	72.0									14
15		2.69	208	48.3									15
16		2.46	149	31.7									16
17		2.35	119	24.2									17
18		2.15 E	95	17.6									18
19		1.95 E	85	14.3									19
20		1.95 E	81	13.6									20
21		1.93 E	79	13.2									21
22		1.93 A	74	12.3									22
23		1.95 E	68	11.5									23
24		2.01 E	63	10.9									24
25		2.07 E	57	10.2									25
26		2.12 E	52	9.52									26
27		2.07 E	47	8.41									27
28		2.01 E	44	7.64									28
29		1.95 A	41	6.91									29
30		1.93 E	40	6.67									30
31		1.90 E	40	6.57									31
TOTAL		107.70		1 999.18									TOTAL
MEAN		3.47		64.5									MEAN

SUMMARY FOR THE MONTHS MAR TO OCT

SUSPENDED SEDIMENT CONCENTRATION(mg/L)	SUSPENDED SEDIMENT LOAD(t/d)
MAXIMUM DAILY 7 460 ON MAY 07	MAXIMUM DAILY 29 700 ON MAY 18

A - MANUAL GAUGE B - ICE CONDITIONS E - ESTIMATED S - SAMPLE(S) COLLECTED THIS DAY

SEDIMENT DATA PARTIALLY CONTRIBUTED BY UNITED STATES GEOLOGICAL SURVEY

TYPE OF GAUGE - RECORDING
LOCATION - LAT 48 59 05 N
LONG 110 28 15 W
DRAINAGE AREA 6 810 km²
REGULATED FLOW SINCE 1917
INTERNATIONAL GAUGING STATION

MILK RIVER AT EASTERN CROSSING OF INTERNATIONAL BOUNDARY - STATION NO. 11AA031

SUSPENDED SEDIMENT FOR 1982

DAY	JAN				FEB				MAR				DAY
	TEMP. (°C)	DAILY DISCHARGE (m^3/s)	MEAN CON-CENTRATION (mg/L)	DAILY LOAD (t)	TEMP. (°C)	DAILY DISCHARGE (m^3/s)	MEAN CON-CENTRATION (mg/L)	DAILY LOAD (t)	TEMP. (°C)	DAILY DISCHARGE (m^3/s)	MEAN CON-CENTRATION (mg/L)	DAILY LOAD (t)	
1										3.11 B			1
2										2.55 B			2
3										1.98 B			3
4										1.56 B			4
5										1.27 B			5
6										0.991 B			6
7										0.850 B			7
8										0.708 B			8
9										0.850 B			9
10										2.83 B			10
11										8.50 B			11
12										19.8 B			12
13										26.9 B			13
14										25.5 B			14
15										22.7 B			15
16										18.4 B			16
17										14.2 B			17
18										9.91 B			18
19										5.66 B			19
20										5.66 B			20
21										7.08 B			21
22										8.50 B			22
23										8.50 B			23
24										5.66 B			24
25										3.68 B			25
26										2.83 B			26
27										4.25 B			27
28										7.08 B			28
29										11.3 B			29
30										18.4 B			30
31										17.0 B			31
TOTAL										268.209			TOTAL
MEAN										8.65			MEAN

DAY	APR				MAY				JUN				DAY
	TEMP. (°C)	DAILY DISCHARGE (m^3/s)	MEAN CON-CENTRATION (mg/L)	DAILY LOAD (t)	TEMP. (°C)	DAILY DISCHARGE (m^3/s)	MEAN CON-CENTRATION (mg/L)	DAILY LOAD (t)	TEMP. (°C)	DAILY DISCHARGE (m^3/s)	MEAN CON-CENTRATION (mg/L)	DAILY LOAD (t)	
1		15.6 B				11.8	910	928	12.0	33.7	2 670 S	7 770	1
2		12.7 B			15.5	11.8	864 S	881		30.3	1 990	5 210	2
3		8.50 B				11.2	771	746	13.5	29.7	1 790 S	4 590	3
4		5.66 B			9.5	10.2	690 S	608	13.0	30.0	2 030 S	5 260	4
5		4.25 B				9.15	611	483	17.0	29.2	2 800 S	7 060	5
6		3.40 B			11.5	9.40	626 S	508		28.1	2 500	6 070	6
7		2.83 B				13.8	820	978	12.5	26.3	1 190 S	3 390	7
8		3.68 B			7.5	16.5	989 S	1 610		25.8	1 300	2 900	8
9		7.08 B				18.2	1 290	2 030	16.0	25.2	1 220 S	2 660	9
10		8.50 B			6.0	27.2	2 340 S	5 500		24.4	1 150	2 420	10
11		9.91 B				25.9	2 060	4 610	19.5	23.6	1 170 S	2 390	11
12		12.7 B			13.0	21.9	1 810 S	3 420		22.1	1 190	2 270	12
13		32.8				21.6	1 850	3 450	19.0	21.2	1 150 S	2 110	13
14		115			12.5	21.6	1 710 S	3 190		21.6	1 150	2 150	14
15		114				21.3	1 490	2 740	24.0	20.6	1 060 S	1 890	15
16		89.8			18.0	22.3	1 460 S	2 810		20.3	1 010	1 770	16
17		51.5				25.1	1 500	3 250	20.0	20.4	1 020 S	1 800	17
18		35.4			16.5	25.8	1 590 S	3 540		19.6	1 130	1 910	18
19		25.5				27.9	1 770	4 270	21.5	19.3	1 050 S	1 750	19
20		20.6			11.5	25.8	1 990 S	4 440		20.9	1 120	2 020	20
21		18.6				23.6	1 880	3 830	24.0	21.4	1 210 S	2 240	21
22		16.5			18.5	25.3	1 910 S	4 180		20.9	776	1 400	22
23		14.8				24.9	1 920	4 130	21.5	23.4	821 S	1 660	23
24		13.5			16.0	22.7	1 660 S	3 260		24.6	955	2 030	24
25		27.9	2 440	5 880		21.9	1 470	2 780	23.0	25.5	894 S	1 970	25
26		31.7	2 910	7 970	13.5	22.6	1 350 S	2 640		26.9	995	2 310	26
27	9.5	25.9	2 730 S	6 110		24.0	1 490	3 090	21.5	26.8	1 150 S	2 660	27
28		18.4	1 740	2 770	8.0	32.3	4 170 S	11 600		27.5	1 170	2 780	28
29	7.0	14.0	1 520 S	1 840		41.1	6 040	21 400	19.5	27.3	1 450 S	3 420	29
30	9.5	12.5	1 160 S	1 250	6.5	43.0	4 740 S	17 600		25.9	1 490	3 330	30
31						41.1	3 900	13 800					31
TOTAL		773.21				700.95		138 102		742.5		91 190	TOTAL
MEAN		25.8				22.6		4 450		24.8		3 040	MEAN

MILK RIVER AT EASTERN CROSSING OF INTERNATIONAL BOUNDARY - STATION NO. 11AA031

SUSPENDED SEDIMENT FOR 1982

	JUL				AUG				SEP				
DAY	TEMP. (°C)	DAILY DISCHARGE (m^3/s)	MEAN CON- CENTRATION (mg/L)	DAILY LOAD (t)	TEMP. (°C)	DAILY DISCHARGE (m^3/s)	MEAN CON- CENTRATION (mg/L)	DAILY LOAD (t)	TEMP. (°C)	DAILY DISCHARGE (m^3/s)	MEAN CON- CENTRATION (mg/L)	DAILY LOAD (t)	DAY
1	23.5	26.8	1 550 S	3 590		9.88	383	327		0.595	51	2.62	1
2		29.7	1 640	4 210	27.5	7.62	260 S	171		0.595	46	2.36	2
3	18.0	29.4	1 660 S	4 220		5.78	191	95.4		0.538	41	1.91	3
4		24.4	1 450	3 060	22.0	4.47	169 S	65.3		0.538	39	1.81	4
5	15.0	20.8	1 260 S	2 260		3.68	151	48.0		0.510	36	1.59	5
6		17.8	1 020	1 570	25.0	3.09	98 S	26.2		0.481	31	1.29	6
7	21.0	17.3	948 S	1 420		2.80	68	16.5		0.453	25	0.98	7
8		16.8	985	1 430		2.49	61	13.1	14.0	0.425	17 S	0.62	8
9	22.0	15.7	1 120 S	1 520		2.01	56	9.73		0.396	16	0.55	9
10		15.9	1 070	1 470	20.0	1.76	56 S	8.52		0.368	15	0.48	10
11	21.0	16.6	782 S	1 120		2.58	317	70.7		0.311	14	0.38	11
12		16.7	843	1 220	18.0	2.78	280 S	67.3		0.283	14	0.34	12
13	24.0	18.6	962 S	1 550		1.98 E	75	12.8		0.311	12	0.32	13
14	22.5	19.4	1 180 S	1 980		1.70 E	45	6.61	10.0	0.311	12 S	0.32	14
15	20.5	19.9	831 S	1 430		1.47 E	44	5.59		0.283	12	0.29	15
16		19.3	576	960		1.27 E	31	3.40		0.311	12	0.32	16
17	14.5	18.6	702 S	1 130	29.0	1.13 E	22 S	2.15		0.340	12	0.35	17
18		19.1	704	1 160		0.991 E	24	2.05		0.340	14	0.41	18
19	22.0	20.2	776 S	1 350	20.0	0.906	27 S	2.11		0.340	16	0.47	19
20		19.3	792	1 320		0.850	26	1.91		0.340	17	0.50	20
21	24.0	19.1	614 S	1 010		0.765	23	1.52	15.0	0.340	19 S	0.56	21
22		19.1	522	861		0.736	50	3.18		0.283	25	0.61	22
23	23.5	18.9	707 S	1 150		0.793	119	8.15		0.283	24	0.59	23
24		18.3	646	1 020	21.5	0.963	214 S	17.8		0.283	28	0.68	24
25	21.5	18.5	509 S	814		0.793	225	15.4		0.283	36	0.88	25
26		18.0	493	767		0.934	182	14.7		0.283	78	1.91	26
27	24.0	18.0	436 S	678		0.878	144	10.9		1.19	965	99.2	27
28		18.3	428	677		0.765	114	7.53		4.56	1 630	642	28
29	23.5	18.1	422 S	660		0.708	90	5.51		2.58	1 450	323	29
30		17.5	423	640		0.708	66	4.04		2.46	1 460	310	30
31	25.5	13.5	424 S	495	15.0	0.651	50 S	2.81					31
TOTAL		599.6		46 742		67.931		1 046.91		20.614		1 397.34	TOTAL
MEAN		19.3		1 510		2.19		33.8		0.687		46.6	MEAN

	OCT				NOV				DEC				
DAY	TEMP. (°C)	DAILY DISCHARGE (m^3/s)	MEAN CON- CENTRATION (mg/L)	DAILY LOAD (t)	TEMP. (°C)	DAILY DISCHARGE (m^3/s)	MEAN CON- CENTRATION (mg/L)	DAILY LOAD (t)	TEMP. (°C)	DAILY DISCHARGE (m^3/s)	MEAN CON- CENTRATION (mg/L)	DAILY LOAD (t)	DAY
1	6.5	1.93	1 290 S	215									1
2		1.59	1 010	139									2
3		1.33	765	87.9									3
4		1.30	539	60.5									4
5		1.42	335	41.1									5
6	4.5	1.33	196 S	22.5									6
7		1.44	150	18.7									7
8	5.0	1.50	123 S	15.9									8
9		1.36	108	12.7									9
10		1.33	96	11.0									10
11		1.30	87	9.77									11
12		1.30	79	8.87									12
13	13.5	1.25	69 S	7.45									13
14	9.0	1.25	60 S	6.48									14
15		1.19	55	5.65									15
16		1.10	51	4.85									16
17		1.02	49	4.32									17
18		1.10	47	4.47									18
19		1.13	44	4.30									19
20		1.25	44	4.75									20
21		1.22	43	4.53									21
22		1.36	44	5.17									22
23		1.50	43	5.57									23
24		1.33	41	4.71									24
25		1.02	40	3.53									25
26		0.963	38	3.16									26
27		0.991	37	3.17									27
28		0.963	37	3.08									28
29		0.991 E	36	3.08									29
30		0.991 E	36	3.08									30
31		0.991 E	35	3.00									31
TOTAL		38.740		727.29									TOTAL
MEAN		1.25		23.5									MEAN

TYPE OF GAUGE - RECORDING
LOCATION - LAT 48 59 05 N
LONG 110 28 15 W
DRAINAGE AREA 6 490 km^2
REGULATED FLOW SINCE 1917
INTERNATIONAL GAUGING STATION

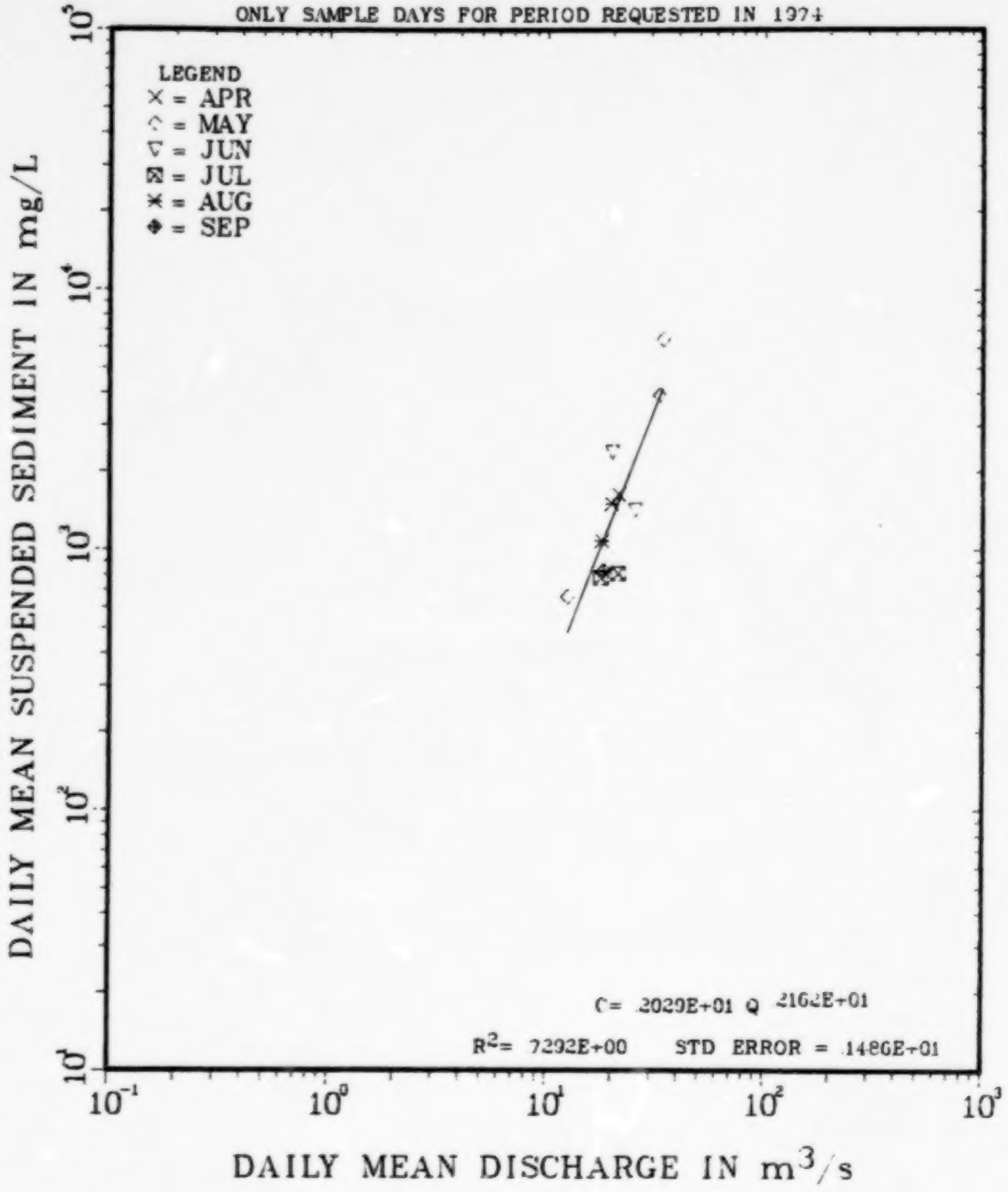
B - ICE CONDITIONS E - ESTIMATED S - SAMPLE(S) COLLECTED THIS DAY

SEDIMENT DATA PARTIALLY CONTRIBUTED BY UNITED STATES GEOLOGICAL SURVEY

MILK RIVER AT EASTERN CROSSING OF INTERNATIONAL BOUNDARY

STATION NO 11AA031

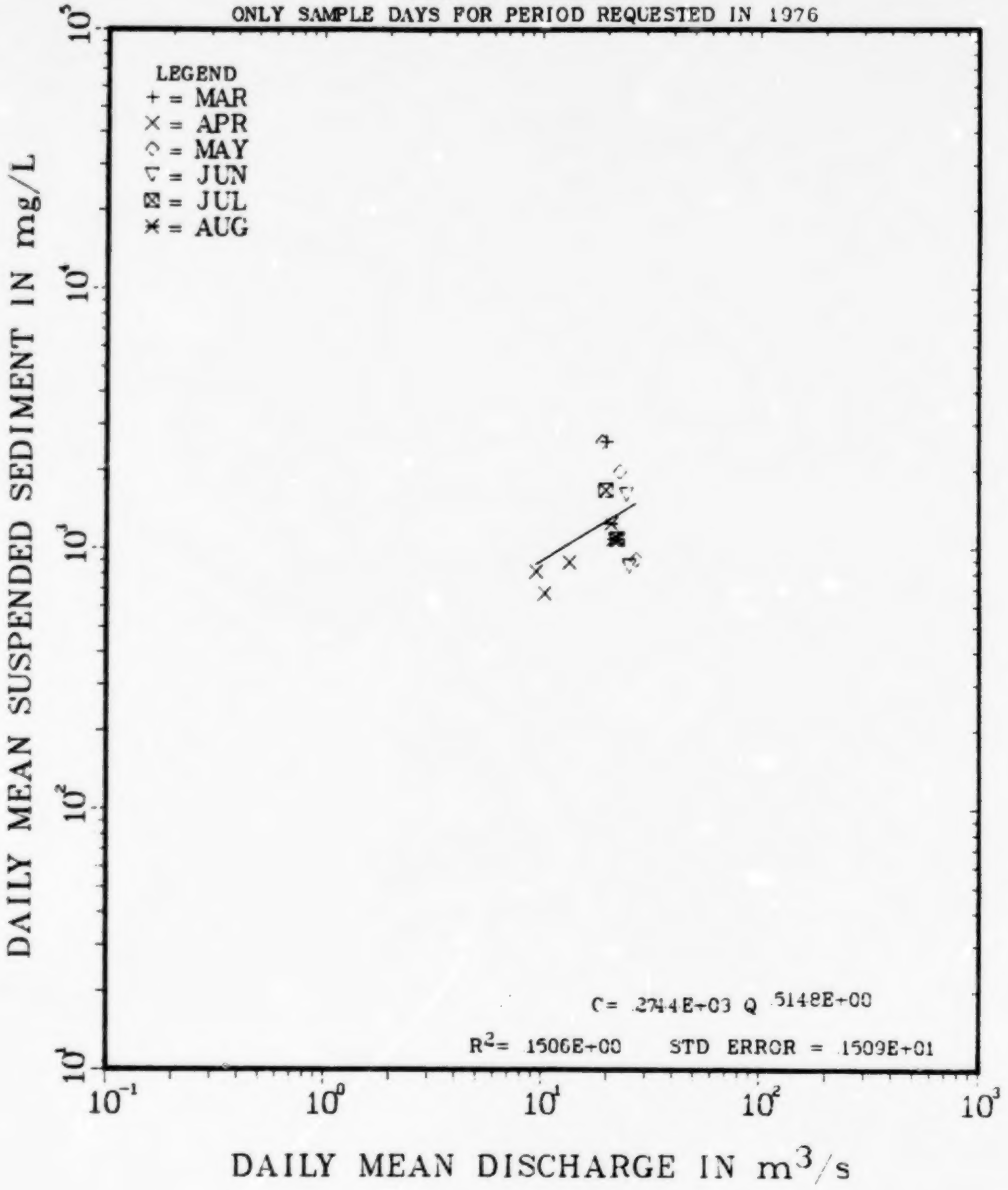
ONLY SAMPLE DAYS FOR PERIOD REQUESTED IN 1974



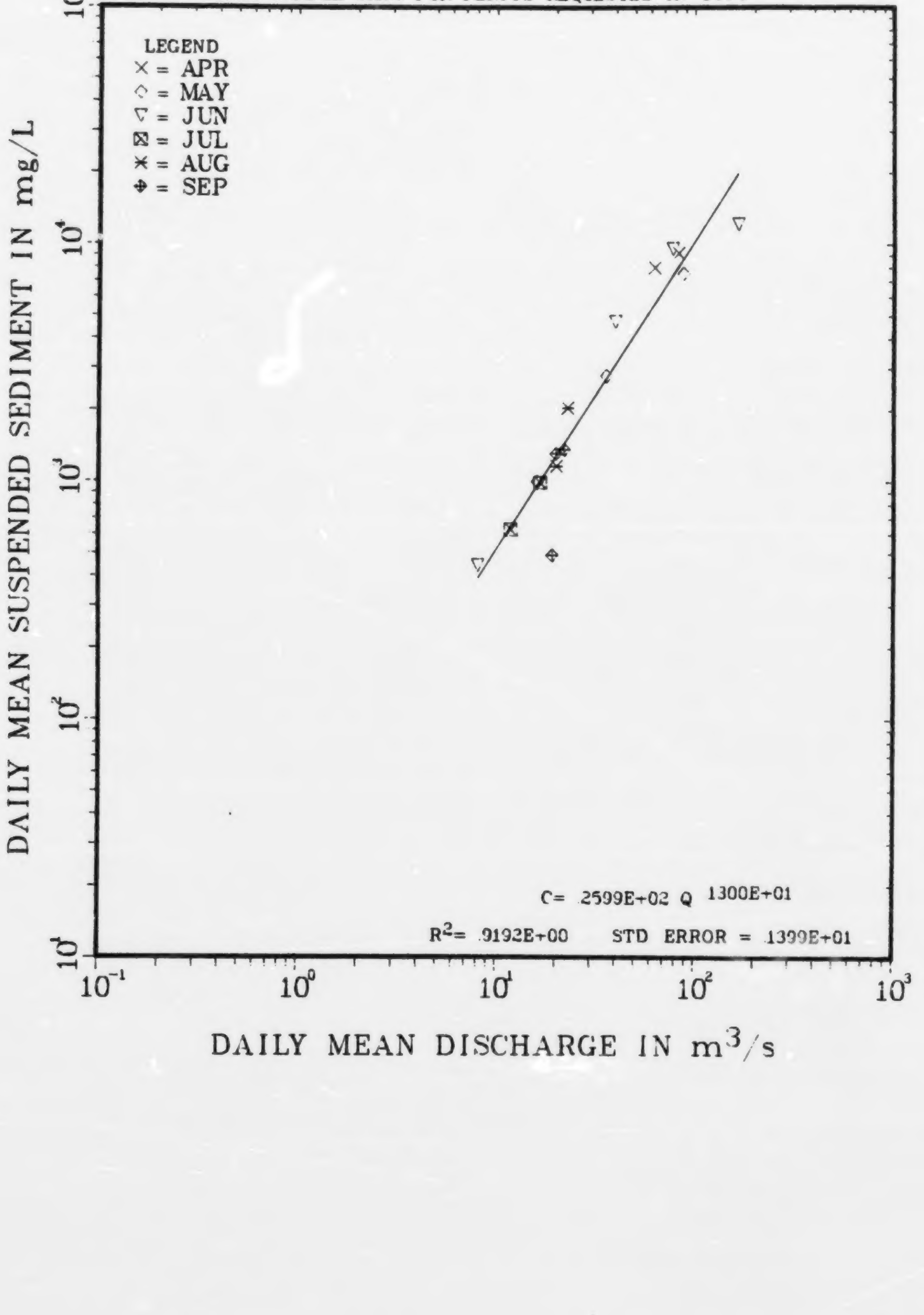
MILK RIVER AT EASTERN CROSSING OF INTERNATIONAL BOUNDARY

STATION NO. 11AA031

ONLY SAMPLE DAYS FOR PERIOD REQUESTED IN 1976



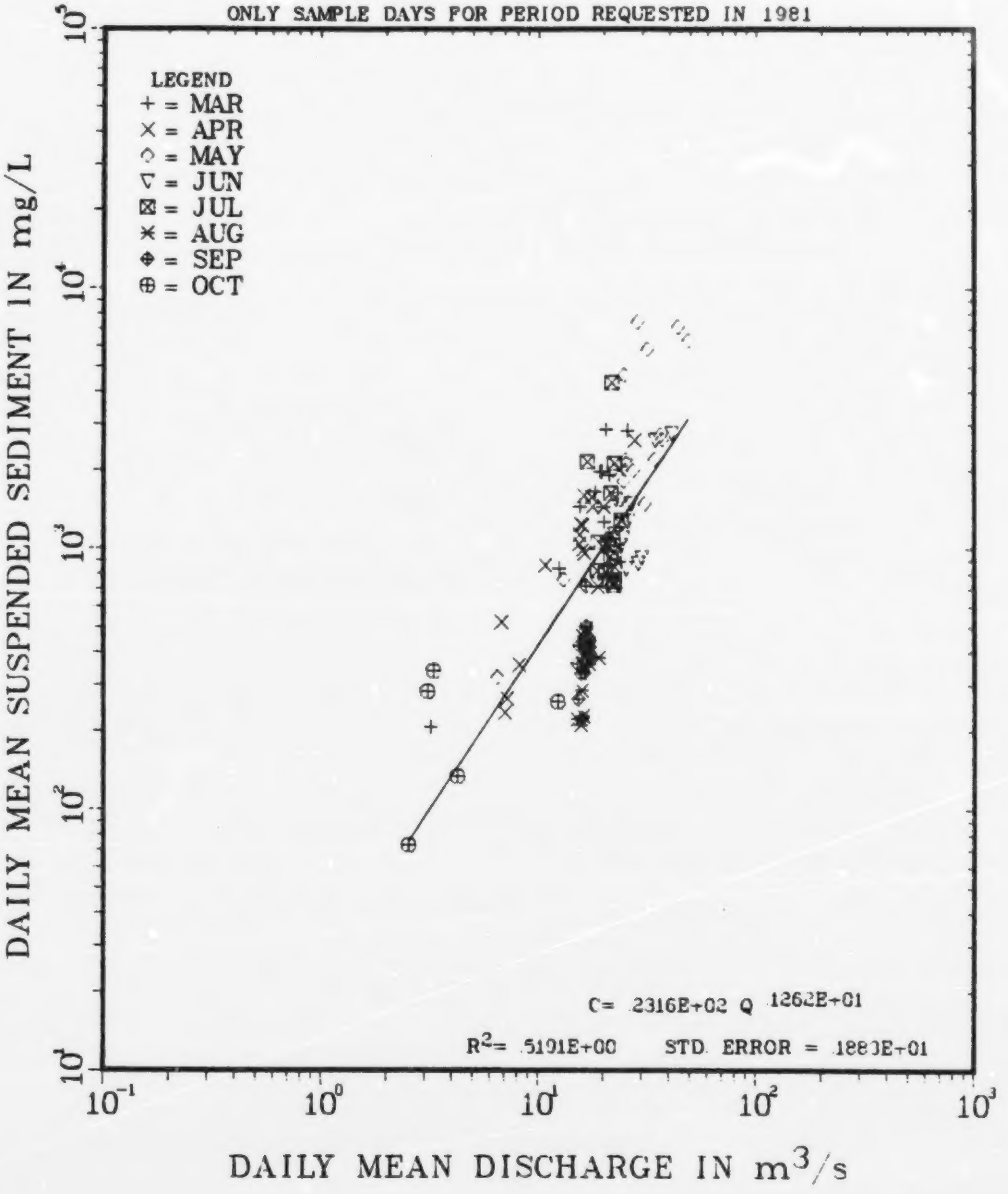
MILK RIVER AT EASTERN CROSSING OF INTERNATIONAL BOUNDARY
STATION NO. 11AA031
ONLY SAMPLE DAYS FOR PERIOD REQUESTED IN 1975



MILK RIVER AT EASTERN CROSSING OF INTERNATIONAL BOUNDARY

STATION NO. 11AA031

ONLY SAMPLE DAYS FOR PERIOD REQUESTED IN 1981



MILK RIVER AT EASTERN CROSSING OF INTERNATIONAL BOUNDARY

STATION NO. 11AA031
ONLY SAMPLE DAYS FOR PERIOD REQUESTED IN 1982